ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF ZOOLOGICAL SCIENCES

THE PREVALENCE OF MALARIA IN OUTPATIENTS ATTENDING DANGILA HEALTH CENTER, NORTH CENTRAL ETHIOPIA

By

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A thesis submitted to the Graduate Program of Addis Ababa University in partial fulfillment of the requirement for the degree of Master of Science in Biology (Zoological Sciences)

Addis Ababa University

August, 2017

ACKNOWLEDEMENT

I would like to thank my advisor, Dr. Fassil Assefa for his unreserved advice. I would like to thank Dangila Health Center for support to collect relevant data on their laboratory registered book. I also want to thank my friends for their moral support. I would like also thank Ethiopia Ministry of Education for its financial support. I would like also thank Addis Ababa University and Biology Department.

ABBREVIATIONS AND ACRONYMS

ACTs	Artemisinin Based combination therapy.
AL	Artemether Lumfantrin
ARDS	Acute respiratory distress syndrome.
IRS	Indoor-residual spraying.
ITNS	Insecticide-treated mosquito nets.
PCR	Polymerase Chain Reaction.
PLDH	Plasmodium Lactate Dehydrogenase.
RBC	Red Blood Cell.
RDT	Rapid diagnostic tests.
SP	Sulfadoxine- Pyrimethamine.
WHO	World Health Organization.

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ABSTRACT

Malaria is one of the leading causes of illness and death in Ethiopia. Over the past years, the disease has been reported as the first leading cause of outpatient visits, hospitalization and death in health facilities across the country. Regardless of decades of sustained control efforts, malaria still remains as the major cause of morbidity, mortality and socio-economic problems in Ethiopia because malaria control is a big challenge due to many factors. Ethiopia developed a five-year National Strategic Plan for Malaria Prevention, Control and Elimination (NSPMPCE) (2011-2015) which was followed from strategic plan developed following the 2007. In this retrospective study secondary data were taken from Dangila Health Center from 2012-2016 to determine the prevalence of malaria in relation to other previous works and the national intervention strategic plans. Accordingly, a total of 22,200 blood films were requested for malaria diagnosis of which 3,688 (16.6%) were confirmed as malaria cases. The highest prevalence of 25.9% was recorded in 2013 followed by the prevalence of 20% in 2012. The lowest infections of 9.1% and 9.2% were recorded in 2015 and 2016, respectively. This indicating 65% and 42 % decrease in malaria infection at the latter periods. The drastic reduction may be due to the intervention activities of the local branch of the NSPMPCE in the Woreda through various activities such as delivery of insecticide treated nets (ITNs) ITNs to the community application of indoor residual spray (IRS) use of effective drug coartem for the treatment of malaria and management of breeding site of the vector. The data also showed more males (64%) were infected than females (36%), and the active age groups of 15-44 and 5-14 were more vulnerable to infection due to their outdoor activities. Regarding the parasites, *Plasmodium vivax* accounted for more infections (69%) than *Plasmodium falciparum* (31%). The highest peak of 37% of malaria cases was recorded between September and November months followed by 27% of infection during the months of June to August. Although the overall pattern

of infection showed the dominance of *P. vivax*, interestingly, the months of September-November and March-May showed slightly higher number of *P. falciparum* cases. In general, the prevalence of malaria decreased in 2015 and 2016 by 16%, indicating control strategies were relevant. However, on the spot surveillance and collection of primary data is necessary to validate the interventions for secondary clinical data were prone to many fluctuations, misdiagnosis, and disorganization of data during recording.

Key words/phrases; Age groups, ITN, national strategy, *P. vivax, P. falciparum, P. ovale, P. malariae, P. knowlesi*.

1. INTRODUCTION

1.1 Background

Malaria is one of the most serious health problems facing the world today. It is caused by infection with parasitic protozoa belonging to the genus *Plasmodium*, The four species of plasmodium are *P. falciparm*, *P. ovale*, *P. vivax* and *P. malariae rarely P. knowlesi* cause malaria in human. The parasites are transmitted to humans by the bite of certain sorts of mosquito called anopheles mosquito (WHO, 2014).The *P. ovale, P. vivax* and *P. malariae* are classified as relapsing malaria because they have a secondary or persisting stage of their life cycle (Perin *et al*., 1984). Symptoms of malaria include fever, headache, backache, joint pains and vomiting, usually appearing between 10 and 15 days after the mosquito bite. If not treated, malaria can quickly become life-threatening by disrupting the blood supply to vital organs.

The World Health Organization (WHO) reported in 2015, there were 95 countries and territories having ongoing malaria transmission with about 3.2 billion people – almost half of the world‟s population- at- risk. In that year 214 million new malaria cases were reported and over 438,000 people died from the disease although there is a drastic global fall in malaria death in recent years (WHO, 2015). Sub–Saharan Africa (SSA) carries a disproportionally high share of the global malaria burden. In the aforementioned same years, the Region was home to 88% and 90% of malaria cases and deaths respectively.

About 75% of the land and 60% of the population is exposed to malaria in Ethiopia. Ethiopia is generally considered as a low-to-moderate malaria transmission intensity country. Malaria should a decline in Ethiopia over the last ten years as a result of high coverage of key malarias

control interventions. This is attributable to the introduction of artemisinin-based combination therapy (ACT), use of rapid diagnostic tests (RDTs) at the peripheral health facilities, wide-scale distribution of long lasting insecticidal nets (LLINs) and high coverage of sprayed households through targeted indoor residual spraying since 2004/2005 (WHO, 2010).Ethiopia developed a five year National Strategic Plan for malaria prevention ,Control and Elimination(2011-2015).this strategic plan was developed following the 2007 MIS,as well as the discussions and recommendations following consultative meeting held in Adama, Ethiopia, in March 2009 with key in country and international malaria stake holders.

Of the four species that infect human beings *Plasmodium falciparum* and *Plasmodium vivax* are the two most dominant malaria parasites in Ethiopia. They are prevalent in all malarious areas in the country (usually below 2000 meters above sea level) with *P. falciparum* representing about 65-75% of the total reported. Malaria cases, relative frequency varying in time and space within a given geographical ranges. Key interventions to control malaria includes prompt diagnosis and effective treatment with appropriate anti-malaria drugs, use of insecticidal bed nets; and indoor residual spraying of houses with insecticides to control the vector population.

According to the PMI a micro planning survey of all districts in 2011 –2012, district level reports in Ethiopia showed that there were 2,475,337 laboratory confirmed *P. falciparum* cases, and 1,174,559 *P. vivax* cases reported (WHO, 2015). Regardless of decades of sustained control efforts, malaria still remains as the major cause of morbidity, mortality and socio-economic problems in Ethiopia because malaria control is a big challenge due to many factors. The complexity of the disease control process, experiences of the control program, resistance of the parasite to anti-malarial drugs and vectors to insecticides are some of the challenges (Deressa *et al*., 2006).

Ethiopia developed a five-year National Strategic Plan for Malaria Prevention, Control and Elimination (2011- 2015) (MIS, 2011). This strategic plan was developed following the 2007 MIS, as well as the discussions and recommendations following a consultative meeting held in Adama, Ethiopia, in March 2009 with key in-country and international malaria stakeholders. The HSDP and the national strategic plan are in line with RBM partnership objectives.

Goals: by 2015, achieve malaria elimination within specific geographical areas with historically low malaria transmission; and by 2015, achieve zero deaths due to malaria in the remaining areas with malaria transmission.

Overall Objective: The objective of the National Strategic Plan for Malaria Prevention and Control 2011-2015 is to consolidate the achievements of the 2006-2010 strategic plan and sustain its impacts (Ethiopia MOP FY, 2014).

Amhara region is one of the low land malarous regions of Ethiopia. The prevalence of malaria in 2011 – 2012 was 4.3% and the prevalence rate among sex was male (4.8%) greater than female (3.4%). The dominant the species of malaria in the region are *P.falciparum* and *P.vivax* (Amhara Region Health Bureau, 2014).

Malaria remains to be the major public health challenge in Amhara region. Among ten zones and three town administrations in Amhara region, Awi zone is one of the malaria risk zones.

1.2. Statement of the problem

Malaria control and interventions have been implemented and the recent past and intensified as an effort to attain the World Health Assembly, Roll Back Malaria, and Millennium Development universal targets with the aim of reducing and interrupt disease transmission in Sub Saharan Africa. In Dangila Woreda malaria control measures such as the use of Artemisinin Combine therapy(ACT), the use of insecticide treated bed net (ITNs), indoor residual spraying of insecticide (IRS) have been implemented. Despite of all these efforts yet malaria is the public health problem of Dangila Woreda. This verifies that there could be several reasons for this situation including the deficiencies in the Health System that leads to lack of access to malaria control interventions and low effectiveness of these interventions than expected. Thus it is very essential that research is conducted to determine the prevalence of malaria cases.

1.3. Objectives of the study

1.3.1. General objectives

The main objective of this study is to determine the prevalence of malaria infection in Dangila Woreda.

1.3.2. Specific objectives

- To estimate the prevalence of malaria based on age and sex.
- To determine the species composition of *P. vivax* and *P. falciparum* in the study area.
- To determine the prevalence of the disease at different seasons.

2. LITERATURE REVIEW

Malaria is a life threatening disease caused by parasites that are transmitted to people through the bites of infected female mosquitoes. Most deaths are caused by *P. falciparum* because *P. vivax, P. ovale* and *P. malariae* generally cause a milder form of malaria. The species *P. knowlesi* rarely causes disease in humans (WHO, 2014).

About 3.2 billion people almost half of the world‟s populations are at risk of malaria. Young children, pregnant women and non-immune travelers from malaria-free areas are particularly vulnerable to the disease when they become infected. Malaria is preventable and curable, and increased efforts are dramatically reducing the malaria burden in many place.(WHO, 2016).

Between 2000 and 2015, malaria incidence among population at risk (the rate of new cases) fell by 37% globally. In that same period malaria death rates among populations at risk fell by 60% globally among all age groups and by 65% among children under five. Sub-Saharan Africa carries a disproportionally high share of the global malaria burden. In 2015 the region was home to 88% of malaria cases and 90% of malaria death (WHO, 2016). Malaria is caused by *Plasmodium* parasites. The parasites are spread to people through the bites of infected female *Anopheles mosquitoes*. The mosquito bites introduce the parasite from the mosquito‟s saliva into a person‟s blood (WHO, 2014).

In 2015, approximately 3.2 billion people-nearly half of the world‟s population- were at risk of malaria. Most of malaria cases and deaths occur in sub-Saharan Africa. However, Asia, Latin America and to a lesser extent the Middle East are also at risk. In 2015 97 countries and territories had ongoing malaria transmission. Some population groups are at considerably higher risk of contracting malaria, and developing severe disease than others. These include infants,

children under five years of age, pregnant women and patients with HIV/AIDS as well as non immune migrants, mobile populations and travelers (WHO, 2015).

2.1. Malaria disease burden

According to the latest estimates, released in December 2015 there were 214 million cases of malaria in 2015 and 438,000 deaths. Between 2000-2015 malaria incidences among populations at risk fell by 37% globally where as mortality rates decreased by 60% (WHO, 2014). In sub-Saharan Africa malaria is the leading cause of death for children under five. Infection during pregnancy, particularly among new mothers, increases the risk of maternal mortality, neonatal mortality, and low birth weight. In addition to loss of life malaria places an economic burden on African nations (WHO, 2014). It is estimates that malaria costs Africa, US$12 million per year in direct costs and reduces GDP growth by 1.3 percent annually. The burden is carried mostly by poor, rural families that have less access to current prevention and treatment services (WHO, 2014).

2.2. Malaria in Ethiopia

About 75% of the land and 60% of the population is exposed to malaria in Ethiopia. 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 consequences on the transmission cycles of vector-borne infection diseases like malaria. Due to the unstable and seasonal transmission of malaria in the country, protective immunity of the population is generally low and all age groups are at risk. Prevalence of malaria is currently estimated to be 1.3 (FMoH, 2007).

Ethiopia has achieved remarkable progress in the fight against malaria during the most recent decade through strong preventive and case management interventions with large engagement of the health extension workers(HEWs) and the health development army (HAD) volunteers providing community based care at the household level (MoH, 2011). In children under five years of age, malaria admissions and death fell by 81% and 73% between 2001 and 2011 respectively.

2.3. The Malaria parasite and its life cycle

The malaria parasite has a complex, multistage life cycle occurring within two living beings, the vector mosquitoes and the vertebrate hosts (figure1). The survival and development of the parasite within the invertebrate and vertebrate hosts, in intercellular and extracellular environment is made possible by a toolkit of more than 5000 genes and their specialized proteins that help the parasite to invade and grow within multiple cell type and to evade host immune responses (Laurence *et al*., 2008).

Mosquitoes are the definitive hosts for the malaria parasites where in the sexual phase of the parasites life cycle occurs. The sexual phase is called sporogony and results in the development innumerable infecting forms of the parasite within the mosquito that induce disease in the human host following their injection with the mosquito bite(Figure 1).

When the female anopheles draws a blood meal from an individual infected with malaria the male and female gametocytes of the parasite find their way into the gut of the mosquito. The molecular and cellular changes in the gametocytes help the parasite to quickly adjust to the insect host from the warm-blooded human host and then to initiate the sporogonic cycle (Carolina and Sanjeev, 2005).

The male and female gametes fuse in the mosquito gut to form zygotes, which subsequently develop into actively moving ookinates that burrow into the mosquito mid gut wall to develop into oocysts . Growth and division of each oocyst produces thousands of active haploid forms called sporozoites. After the sporogonic phase of 8-15 days, the occyst bursts and releases sporozoites into the body cavity of the mosquito, from where they travel to and invade the mosquito salivary glands.when the mosquito thus loaded with sporozoites takes another blood meal, the sporozoites get injected from its salivary glands into the human blood stream, causing malaria infection in the human host. It has been found that the infected mosquito and the parasite mutually benefit each other and there by promote transmission of the infection. The plasmodium infected mosquitoes have a better survival and show an increased rate of blood feeding, particularly from an infected host (Carolina and Sanjeev, 2005).

With the mosquito bite, tens to a few hundred invasive sporozoites are introduced into the skin, following the intradermal deposition some sporozoites are destroyed by the local macrophages, some enter the lymphatics, and some others find a blood vessel (Ashley *et al*., 2008). The sporozoites that enter alymphatic vessel reach the draining lymphnode where in some of the sporozoites partially develop into exoerythrocytic stage (Ashley, 2008)and may also prime the T cells to mount a protective immune response (Michael and Denise, 2007).

The sporozoites that find a blood vessel reach the liver within a few hours. It has recently been show that the sporozoites travel by a continuous sequence of stick-and- slip motility, using the thrombospondin- related a anonymous protein (TRAP) family and an actin-myosin motor. The sporozoites then negotiate through the liver sinusoids, and migrate into a few hepatocytes, and then multiply and grow within parasitophorous vacuole. Each sporozoite develops into a schizont containing 10,000-30,000 merozoites (Kebaier *et al*., 2009).

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

The merozoites that develop within the hepatocyte are contained inside host cell-derived vesicles called merosomes that exit the liver intact thereby protecting the merozoites from phagocytosis by kupffer cells. These merozoites are eventually released into the blood stream at the lung capillaries and initiate the blood stage of infection thereon.

In *P.vivax* and *P. ovale* malaria, some of the sporozoites may remain dormant for months within the liver. Termed as hyponozoites, these forms develop into schizonts after some latent period, usually of a few weeks to months. It has been suggested that these late developing hypnozoites are genotypically different from the sporozoites that cause acute infection soon after the inoculation by a mosquito bite and in many patients cause relapses of the clinical infection after weeks to months (Olivier, 2008).

Red blood cells are the center stage for the asexual development of the malaria parasite. Within the red blood cells repeated cycles of parasitic development occur with precise periodicity and at the end of each cycle, hundreds of fresh daughter parasites are released that invade more number of red blood cells.The merozoites released from the liver recognize, attach and enter the red blood cells (RBCs) by multiple receptor-ligand interactions in as little as 60 seconds. This quick disappearance from the circulation into the red cells minimizes the exposure of the antigens on

the surface of the parasite there by protecting these parasite forms from the host immune response (William, 2007).

The invasion of the merozoites into the red cells is facilitated by molecular interactions between distinct ligands on the merozoite and host receptors on the erythrocyte membrane. *P.vivax* invades only Duffy blood group positive red cells, using the Duffy-binding protein and the reticulocyte homology protein, found mostly on the reticulocytes. The more virulent *P. falciparum* uses several different receptor families and alternate invasion pathways that are highly redundant. Varieties of duffy binding –like (DBL) homologous proteins and the reticulocyte binding –like homologous proteins of *P. falciparum* recognize different RBC receptors other than the duffy blood group or the reticulocyte receptors. Such redundancy is helped by the fact that *P. falciparum* has four duffy binding-like erythrocyte-binding protein genes, in comparisons to only one gene in the DBL-EBP family as in the case of *P.vivax* allowing *P. falciparum* to invade any red blood cell (Ghislaine *et al*., 2009).

The process of attachment, invasion and establishment of the merozoite into the red cells is made possible by the specialized apical secretary organelles of the merozoite, called the micronemes, rhoptries and dense granules. The initial interaction between the parasite and the red cells stimulates a rapid "wave" of deformation across the red cell membrane, leading to the formation of a stable parasite-host cell junction(figure:1). Following this, the parasite pushes its way through the erythrocyte bilayer with the help of the actin myosin motor, proteins of the thrombosponding-related anonymous protein family (TRAP) and aldolase, and creates a parasitophorous vacuole to seal itself from the host cell cytoplasm thus creating a hospitable

environment for its development within the red cell, at this stage the parasite a appear as an intracellular “ring” (Laurence *et al*., 2002).

Within the red blood cells the parasite numbers expand rapidly with a sustained cycling of the parasite population. Even Though the red blood cells provide some immunological advantage to the growing parasite, the lock of standard biosynthetic path ways and intra cellular Organelles in the red blood cells tend to create obstacles for the fast-growing intra cellular parasites. These impediments are overcome by growing ring stages by several mechanisms: by restriction of the nutrient to the abundant hemoglobin, by dramatic expansion of the surface area through the formation of a tub vesicular net work, and by export of a range of remodeling and virulence factors into the red blood cell(Olivier *et al.*, 2008).

Hemoglobin from the red blood cell, the principal nutrient for the growing parasite, is ingested in to a food vacuole and degraded. The amino acids thus made available are utilized for protein bio synthesis and the remaining toxic heme is detoxified by heme polymerase and sequestrated as hemozoin (malaria pigment) . The parasite depends on anaerobic glycolysis for energy, utilizing enzymes such as PLDH, plasmodium aldolase etc. As the parasite grows and multiplies with in red blood cell the membrane permeablility and cytosolic composition of the host cell is modified (Virgilio *et al*., 2003).

These new permeation path way induced by the parasite in the host cell membrane help not only in the uptake of solutes from the extra cellular medium but also In the disposal of metabolic wastes, and in the origin and maintenance of electro chemical ion gradients. At the same time ,the premature hemolysis of the highly permeabilized infected red blood cells is prevented by the

excessive ingestion, digestion and detoxification of the host cell hemoglobin and its discharge out of the infected RBCs through the new permeation path ways, there by preserving the osmotic stability of infected red blood cells(Kieran , 2001).

The erythrocyte cycle occurs every 24 hours in case of *P. knowlesi*, 48hours in cases of *P. falciparum*, *P. vivax*, *P. ovale* and 72 hours in case of *P. malariae*. During each cycle, each merozoite grows and divided within the vacuole in to 8-32 (average 10) fresh merozoites, through the stages of ring, trophozoite and schizont. At the end of the cycle, the infected red blood cells rupture, releasing the new merozoites that in turn infected more RBCs. With sun bridled growth, the parasite number can rise rapidly to levels as high as 1013 per host (Brian *et al*., 2008).

A small proportion of asexual parasites do not undergo schizogony but differentiate in to the sexual stage gametocytes. These male or female gametocytes are extracellular and nonpathogenic and help in transmission of the infection to others through the female anopheline mosquitoes, where in they continue the sexual phase of the parasites life cycle.

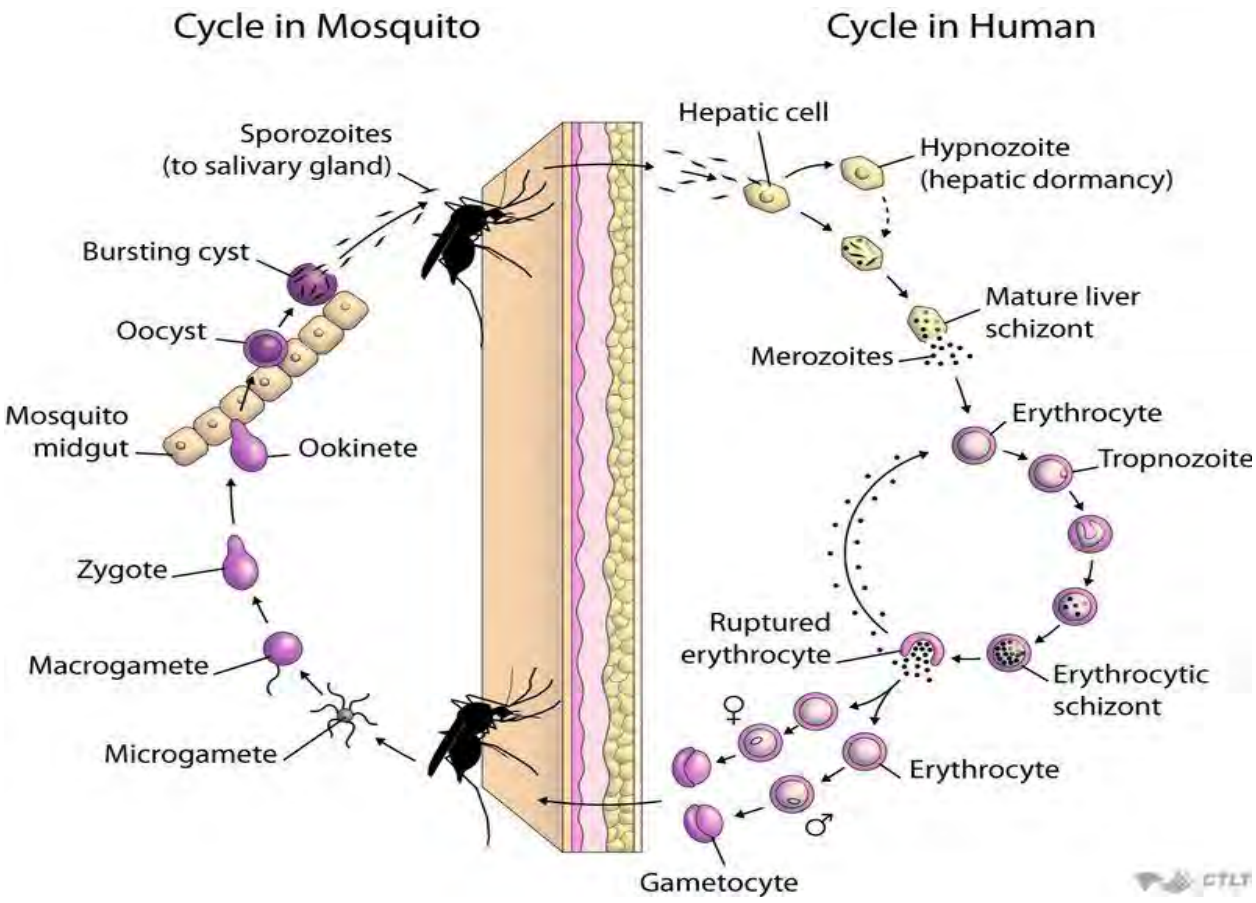

Figure1. The life cycle of malaria parasites (source: htt://ocw.jhsph.edu).

2.4. Symptoms of malaria

The sing and symptoms of malaria typically begin 8-25 days following infection, However symptoms may occur later in those who have taken anti malarial medication as prevention. Initial manifestations of the disease common to all malaria species are similar to flu-like symptom, and can resemble other conditions such as gastroenteritis and viral diseases. The presentation may include headache, fever, shivering, joint pain, vomiting, hemolytic anemia, jaundice, hemoglobin in the urine, retinal damage and convulsion (Beare *et al*., 2006).

The classical symptom of malaria is paroxysm- a cyclical occurrence of sudden coldness followed by shivering and then fever and sweating, occurring every two days in *P. ovale* infection and every three days for *P. malariae*. *P. falciparum* infection can cause recurrent fever every 36-48 hours, or a less pronounced and almost continuous fever (Ferri, 2009).

Almost all severe forms and deaths from malaria are caused by *P. falciparum* rarely *P. vivax* or *p. ovale* produce serious complications, debilitating relapses and even death. The major complications of sever malaria include cerebral, pulmonary edema, acute renal failure, sever-anemia and bleeding. Acidosis and hypoglycemia are the most common metabolic complications. (Bartoloni and Zammarchi, 2012). In various studies risk factors for severe malaria and death include age greater than 65 years, female sex (especially when associated with pregnancy), non immune status, coexisting medical conditions, no anti malarial prophylaxis, delay in treatment (Bear *et al*., 2006).

Symptoms of malaria can recur after varying symptom-free periods. Depending up on the cause, recurrence can be classified as recrudescence, relapse or re-infection (WHO, 2010). Recurrence is due to one of the following; a) therapeutic failure resulting from non adherence to treatment, resistance of the parasite to the drugs used, poor quality of the medication; b) reactivation of hypnozoites and c) exposure to new infection by the mosquito vector.

Recrudescence is when symptoms return after a symptom-free period. It is caused by parasites surviving in the blood as a result of inadequate or ineffective treatment. This is occurs more frequently in malaria from *P. falciparum*, *P. vivax* and rarely with *P. malariea* (White, 2011).

Relapse is resurgence of parasitemia and clinical manifestations due to reinvasion of the erythrocytes by merozoites from dormant hypnozoites in the liver. Relapses are believed to occur

21 to 140 days after treatment of the tropical strain and 180 to 420 days after treatment of the temperate strain. The main cause is treatment failure. Based on clinical observation alone, it is very difficult to distinguish recrudescence from relapse or relapse from re-infection. In some situation the distinction can be made by identifying a parasite genotype in the relapse which is identical to that of the primary infection .Relapse commonly seen with *P. vivax* and *P. ovale* infections (White, 2011).

Re-infection means the parasite that caused the past infection was eliminated from the body but new parasite was introduced. In genotyping, re-infection can be defined by finding a parasite that is genetically different from the one that cause the primary infection (Markus, 2011).

Almost all severe forms and deaths from malaria are caused by *P. falciparem* .Rarely, *P. vivax* or *P. ovale* produce serious complications, debilitating relapses and even death. The major complications of severe malaria include severe anemia and bleeding. Acidosis and hypoglycemia are the most common metabolic complications. Any of these complications can develop rapidly and progress to death within hours or days (WHO, 2000).

In many patients, several of these complications exist together or evolve in rapid succession within a few hours. In clinical practice patients must be assessed foe any of these signs or symptoms that sagest an increased risk for developing complications and must be treated immediately. In various studies risk factors for severe malaria and death include age greater than 65 years, female sex (especially when associated with pregnancy), non immune status, coexisting medical conditions, no malarial prophylaxis, delay in treatment, and severity of the illness at admission (coma, acute renal failure, shook, pulmonary endema, coagulation disorders (Bruneel *et al*., 2003).

In tropical countries with a high transmission of malaria (hyper endemic area), severe malaria is predominantly a disease of young children (1 month to 5 years age). In industrialized countries, most life threatening complications occur in no immune travelers returning from endemic area (Gento *et al.*, 2001).

Cerebral malaria is the most common clinical presentation and cause of death in adults with severe malaria. The onset may be dramatic with a generalized convulsion, or gradual with initial drowsiness and confusion followed by coma lasting for several hours to days. The strict definition of cerebral malaria requires the presence of *P. falciparem* parasitemia and the patient to be unrousable with a glasgos coma scale score 9 or less and other causes (hypoglycemia, bacterial meningitis and viral encephalitis) ruled out (Warrell *et al.*, 1982).

Acute lung injury usually occurs a few days in to the disease course. It may develop rapidly, even after initial response to anti malarial treatment and clearance of parasitemia. The first indication of impending pulmonary edema includes tachypnea and dyspnea, followed by hypoxemia and respiratory failure requiring intubation. Pulmonary edema is usually non cardiogenic and may progress to acute respiratory distress syndrome (ARDS) with an increased pulmonary capillary permeability. Acute lung injury is defined as the acute onset of bilateral pulmonary infiltrates with an arterial oxygen tension /fractional inspires oxygen ratio of 300 mmHg or less, a pulmonary artery wedge pressure of 18mmHg or less and on evidence of left atrial hypertension (Gachot *et al*., 1995).

Acute renal failure is usually oliguric(< 400ml/day) or anuric (<50ml/day), rarely non oliguric and may require temporary dialysis. Urine sediment usually is not remarkable. In severe cases, acute tubular necrosis may develop secondary to renal ischemia. The term „black water fever"

refers to passage of dark red, brown, or black urine secondary to massive intravascular hemolysis and resulting hemoglobin urine. Usually this condition is transient and not accompanied by renal failure (Mehta *et al*., 2001).

Hypoglycemia is a common feature in patients with severe malaria. It may be over looked because all clinical features of hypoglycemia (anxiety, dyspnea, tachycardia, sweating, coma, abnormal posturing, and generalized convulsions) are also typical of severe malaria itself (Mehta *et al*., 2001).

Malaria infection develops via two phases: one that involves the liver (exoerythrocytic phase) and one that involves red blood cell or erythrocytes (erythrocytic phase). When an infected mosquito pierces a person‟s skin to take a blood meal, sporozoites in the mosquito‟s saliva enter the blood stream and migrate to the liver where they infect hepatocytes multiplying asexually and asymptomatically for a period of 8-30 days (Bledsoe, 2005). After a potential dormant period in the liver these organisms differentiate to yield thousands of merozoite which following rupture of their host cells, escape in to the blood and infect red blood cells to begin the erythrocytic stage of the life cycle (Bledsoe, 2005).

The parasite escapes from the liver undetected by wrapping itself in the cell membranes of the infected host liver cell. Within the red blood cells the parasite multiply further again asexually, periodically breaking out their host cells to invade fresh red blood cells. Several such amplification cycles occur. Thus classical descriptions of waves of fever arise from simultaneous wave of merozoites escaping and infecting red blood cells. Some *P. vivax* sporozoites do not immediately develop into exoerythrocytic phase merozoites, but instead produce hypnozoites that remain dormant for periods ranging from several months(7-10 months is typical) to several

years. After a period of dormancy they reactivate and produce merozoites. Hypnozoites are responsible for long incubation and late relapses in *Plasmodium vivax* infection (White, 2011).

The parasite is relatively protected from attack by the body‟s immune system because for most of its human life cycle it resides with in the liver and blood cells and is relatively invisible to immune surveillance. However, circulating infected blood cells are destroyed in the spleen. To avoid this fate, the *P. falciparum* parasite displays adhesive proteins on the surface of the infected blood cells, causing the blood cells to stick to the walls of small blood vessels, there by sequestering the parasite from passage through the general circulation and spleen (Tilley *et al*., 2011). The blockage of the micro vasculature causes symptoms such as in placental malaria, sequestered red blood cells can breach the blood-brain barrier and cause cerebral malaria (Renia *et al*., 2012).

2.5. Genetic resistance against malaria

According to a 2005 review, due to the high levels of mortality and morbidity caused by malaria especially the *P. falciparum* species it has placed the greatest selective pressure on the human genome in recent history. Several genetic factors provided some resistance to it including sickle cell trait, thalassaemia traits, glucose-6-phosphate dehydrogenase deficiency, and the absence of Duffy antigens on red blood cells (Kwaiatkowski, 2005)

The impact of sickle cell trait on malaria immunity illustrates some evolutionary trade-offs that have occurred because of endemic malaria. Sickle cell trait causes a change in the hemoglobin molecule in the blood. Normally red blood cells have a very flexible biconcave shape that allows them to move through narrow capillaries, however, when the modified hemoglobin molecules are exposed to low amounts of oxygen or crowd together due to dehydration, they can stick

together forming stranding that cause the cell to sickle or distort into a curved shape . In these stands the molecule is not as effective in taking or releasing oxygen, and the cells not flexible enough to circulate freely. In the early stages of malaria the parasite can cause infected red cells to sickle, and so they are removed from circulation sooner. This reduces the frequency with which malaria parasite complete their life cycle in the cell. Individuals who are homozygous (with two copies of the abnormal hemoglobin beta allele) have sickle- cell anemia, while those who are heterozygous (with one abnormal allele and one normal allele) experience resistance to malaria without severe anemia. Although the shorter life expectancy for those with the homozygous condition would tend to disfavor the traits survival, the trait is preserved in malaria prone regions because of the benefits provided by the heterozygous form (Hedrick, 2011).

2.6. Diagnosis of malaria

The most economic, preferred, and reliable diagnosis of malaria is microscopic examination of blood films because each of the four major parasite species has distinguishing characteristics. Two sorts of blood film are traditionally used. Thin films are similar to usual blood films and allow species identification because the parasite‟s appearance is best preserved in this preparation. Thick films allow the microscopist to screen a larger volume of blood and are about eleven times more sensitive than the thin film, so picking up low levels of infection is easier on the thick film, but the appearance of the parasite is much more distorted and therefore distinguishing between the different species can be much more difficult (Warhurst and Williams, 1996).

From the thick film an experienced microscopist can detect parasite levels (or parasitemia) as few as fire parasites/μL 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). *Plasmodium malaria* and *P. knowlesi* (which is common cause of malaria in south east Asia) look very similar under the microscope. However *P. knowlesi parasitemia* increases very fast and causes more sever disease than *P. malariae*, so it is important to identify and treat infections quickly. Therefore modern methods such as PCR (see, molecular methods below) or monoclonal antibody panels that can distinguish between the two should be used in this part of the world(Mc Cutchen *et al*., 2008).

For areas where microscopy is not available, or where laboratory staff are not experienced at malaria diagnosis, there are commercial antigen detection test that require only a drop of blood (pattansins *et al*., 2003). Immunochromatographic tests (also called malaria Rapid diagnostic test) antigen capture Assay or Dipsticks) have been developed, distributed and field tested. These tests use finger-stick or venous blood, the completed test takes a total of 15-20 minutes, and the results are read visually as the presence or absence of colored stripes on the dipstick, so they are suitable for use in the field. The first rapid diagnostic tests were using plasmodium glutamate dehydrogenase as antigen. 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 isoenzymes. Antibody tests can also be directed against other malarial antigens such as the *P. falciparum* specific HPRz. (Ling *et al*., 1986).

Molecular methods are available in some clinical laboratories and rapid real-time assay (for example polymerase chain reaction) are being developed with the hope of being able to deploy them in endemic areas. PCR (and other molecular method) is more accurate than microscopy. However, it is expensive, and requires a specialized laboratory. Moreover, levels of parasitemia

are not necessarily correlative with the progression of disease, particularly when the parasite is able to adhere to blood vessel walls. Therefore more sensitive, low-tech diagnosis tools need to be developed in order to detect low levels of parasitemia in the field (Redd *et al*., 2006).

2.7. Treatment of malaria

Malaria is treated with anti malarial drugs and measures to control symptoms, including medications to control fever, ant seizure medications when needed, fluids and electrolyted. The type of medications that are used to treat malaria depends on the severity of the disease and likelihood of chloroquine resistance. The drugs available to treat malaria include: chloroquine; Quinine, Hydroxychloroquine(coartem) , Atovaquone(Mepron), proguanil(sold as a generic), mefloquine, clindamycin(cleocin), Doxycycline (Watrs and Edstein, 2012).

People with falciparum malaria have the most severe symptoms. People with falciparum malaria may need to be monitored in the intensive care unit of a hospital during the first day of treatment because the disease can cause breathing failure, coma, and kidney failure. For pregnant women, chloroquine is the preferred treatment for malaria. Quinine, proguanil and clindamycin typically are used for pregnant people with malaria that is resistant to chloroquine (Waters and Edstein, 2012).

Intravenous quinine is currently the most widely used agent in the treatment of severe *falciparum* malaria, usually formulated as a dihydrochioride salt. In the USA, quinidine gluconate (the dextrorotatory optical diasteroisomer of quinine) is the only available intravenous anti-malarial agent, and it may be used instead of quinine. Quinidine has a two-fold to threefold greater anti malarial activity than does quinine, but it is also more cardiotoxic and mandates electrocardiographic monitoring (White, 1999).

Parenteral chloroquine is the drug of choice for severe chloroquine susceptible *P.falciparem* infections and for those rare cases of life threatening malaria caused by *P.ovale, P. malariae* and *P. vivax* (except for infections from Papua New Guinea, Sumatra, Irian Jaya, Myanmar, Vanuatu, India and the Amazon region of Brazil (Hatz, 2001). Chloroquine may have more rapid effect on lowering parasitemia than either quinine or quinidine, but it also has a more profound hypotensive side effect.

Artemisinin derivatives clear parasites from blood about 20% faster than quinine dihydrochlorids, improved survival was observed only in regions of south East Asia with recognized quinine resistance. Furthermore, recovery from coma may be delayed and the incidence of seizures was higher than with quinine dihydrochloride. At present, artemisinin derivatives are recommended for treatment of quinine resistant *P. falciparem* infections, combined with mefloquie, doxycycline or clindamycin to prevent recrudescence (Pittler, 1999).

2.8. Anti-malarial drug resistance

Drug resistance is defined as the ability of a parasite to survive and multiply despite administration and absorption of a drug given in doses equal to or higher than those usually recommended , but within the limits of tolerance of the subject (WHO,2001).The successful treatment of malaria requires the administration of an effective anti malarial regimen that result in the clearance of all the parasite from the blood , resolution of symptoms of acute disease and prevention of recrudescent infection(Price and Nosten, 2001).

P. falciparem which is the most deadly plasmodium species in Africa has developed resistance to the cheap and safe anti-malarial such as chloroquine and sulfadoxine-pyrimethamine (SP) (Witkowski *et al.*, 2009). Due to spread of resistance to SP and chloroquine mono therpaies, the

use of artemisinin based combination anti malarial therapies was recommended by WHO. The recommended ACTs include artemether lumfantrin (AL), artesunate- amodiaquin(AS-AQ)and artesunat- mefloquine (AS +MQ). For an effective combination therapy, both partner drugs must be reasonably efficacious (Krishnaa *et al*., 2024).

Artemisinis are highly potent anti malarial drugs and are also active against early stage gametocyte. To date clinical resistance has been reported only at Thaicmbodian border since they were first introduced in 1972 (WHO, 2011). The drugs have short half- life and act very fast .They clear over 90% of the parasite load within the first 6 hours of administration and the rest of load is slowly eliminated by the partner drugs that usually has longer half-life and acts slowly. Hence fewer parasites are exposed to sub-therapeutic level which is a potential factor for the selection and spread of resistance (Makanga and Krudsood, 2009).

2.9. Prevention and control of malaria

Methods used to prevent malaria include medications, mosquito eliminating and the prevention of bites, there is no vaccine for malaria. The presence of malaria in an area requires a combination of high human population density, high anopheles mosquito population density and high rate of transmission from humans to mosquitoes and from mosquitoes to humans. If any of these is lowered sufficiently, the parasite will eventually disappear from that area. As happened in North America, Europe and part of the Middle East (WHO, 1958).

Vector control refers to methods used decrease malaria by reducing the levels of transmission by mosquitoes. For individual protection, the most effective insect repellents are based on DEET or picaridin. Insecticide- treated mosquito nets (ITNs) and indoor residual spraying (IRS) have been

shown to be highly effective in preventing malaria among children in areas where malaria is common (Tanser *et al.*, 2012).

Mosquito nets help keep mosquitoes away from people and reduce infection rates and transmission of malaria. Nets are not a perfect barrier and often treated with an insecticide designed to kill the mosquito before it has time to find a way past the net. Insecticides treated nets are estimated to be twice as effective as untreated nets and often greater than 70% protection compared with no net. Indoor residual spraying is the spraying of insecticides on the walls inside a home. After feeding, many mosquitoes rest on a nearby surface while digesting the blood meal, so if the walls of houses have been coated with insecticides, the resting mosquitoes can be killed before they can bite another person and transfer the malaria parasite. As of 2006, the world health organization recommends 12 insecticides in IRS operations, including DDT and the pyrethroids cyfluthrin and delta methrin (WHO, 2006).

There are a number of other methods to reduce mosquito bites and slop the spread of malaria. Efforts to decrease mosquito‟s larva by decreasing the viability of open water in which they develop or by adding substances to decrease their development is effective in some locations (WHO, 2006).

Community participation and health education strategies promoting awareness of malaria and the importance of control measures have been successfully used to reduce the incidence of malaria in some areas of the developing world. Recognizing the disease in the early stages can stop the disease from becoming fatal. Education can also inform people to cover areas of stagnant, still water such as water tanks that are ideal breading grounds from the parasite and mosquito, thus cutting down the risk of the transmission between people (Lalleo *et al*., 2006).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted at Dangila Health Center, Dangila District which is located in Awi zone, Amhara region, and 485km north to Addis Ababa. This town has a latitude and longitude of 11.267^0N 36.833^0E with an elevation of 2137meter above sea level. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this District had a total population of 158,688, an increase of 6.44% over the 1994 census ,of whom 80, 234 were men and 78,453 women; 27,001 or 17.02% were urban residents. With an area of 918.40 square kilometer s, Dangila has a population density of 172.79, persons per square kilometer. A total of 35,610 households with an average of 4.64 persons to a household were registered (Census 2007).

3.2. Study design

A retrospective study was conducted to determine the prevalence of malaria by reviewing blood film malaria reports of 5 years (2012-2016) at Dangila Health Center. In this Health Centre there are well registered data of malaria.

3.3. Data analysis

Data was analyzed by SPSS version 21(T-Test) and Microsoft Excel finally the data was described and presented using tables by descriptive statistics.

3.4. Ethical considerations

This data was collected after ethical clearance was obtained from Addis Ababa University. After discussing the purpose of the study, written permission was sought from the head of Dangila Health Center to collect the data.

4. RESULTS AND DISCUSSION

4.1. Annual malaria cases in Dangila Health Center from 2012-2016

A total of 22,200 blood film samples were collected and tested for malaria diagnosis at Danigla Health Center from 2012 up to 2016 of which 3,688 (16.6%) of the samples were microscopically confirmed as malaria cases (Table 2).The data showed a down ward trend in malaria infection except 2013. Accordingly, the highest prevalence of 25.9% was recorded in 2013 which was higher by 6% than prevalence recorded in 2012 (20%), followed by an abrupt decrease by 12% in 2014 ($p \leq 0.05$) (P=0.027). (Figure 2).

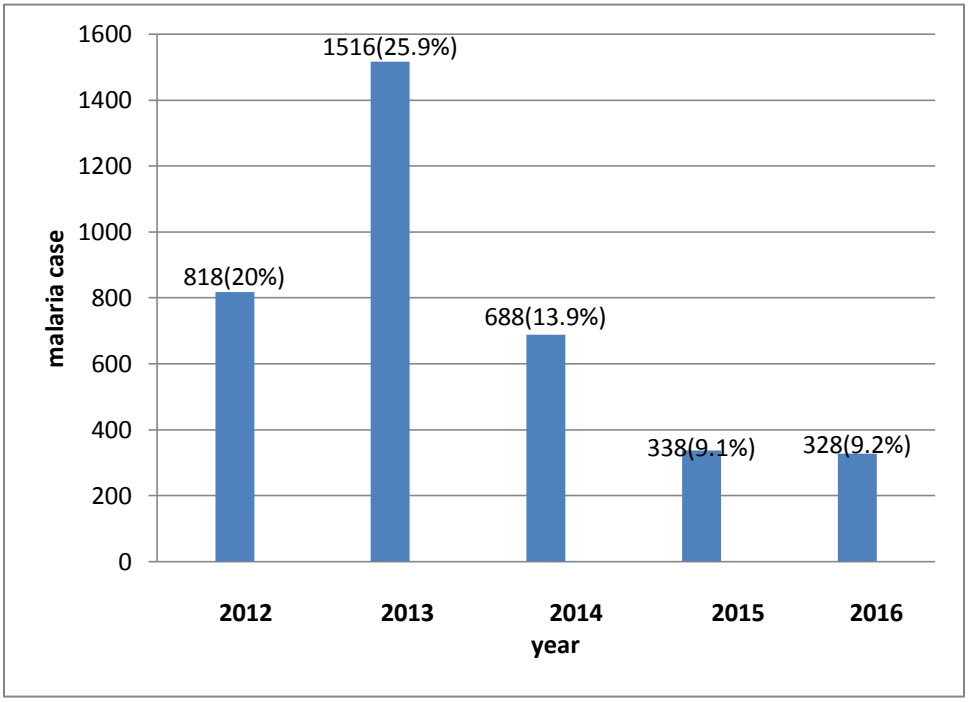

Figure 2. Annual cases of malaria in Dangila from 2012–2016

The data showed an overall prevalence of 16.6% which was similar to the record of 17% from Metema Hospital (Getachew *et al*., 2013), and significantly lower than the prevalence of 64%

recorded in Halaba special Woreda from 2005 – 2010 (Lemma, 2011), and the prevalence of 39.6% reported from Kola Diba wereda from 2002 – 2011 (Alemu *et al*., 2011). The data also showed a progressive decrease in malaria from 20-26% (2012/2013 to 9% (2015/16) ($p \leq 0.05$).which was a reduction of malaria by 42% and 65% respectively. There was also a substantial decrease in malarial infection in 2014 and 2015 by 54% and 70% compared to the infection rate of the previous years (2013), respectively in Mota town (Tilahun, 2016).

The difference in the prevalence of malaria in this study and the study conducted in different place before might be due to variation in the study area, period, sample size used, and climatic conditions. The fact that the collected data in this study was within the period of 2012-2016 that coincided with the increased attention to malaria control and preventive activities by different responsible bodies, The country developed the five-year national Strategic Plan for Malaria prevention, Control and Elimination (2011-2015) with key in-country and international malaria stakeholders (MIS, 2011).

Accordingly, various activities such as delivery of insecticide treated nets (ITNs) ITNs to the community by Dangila Health Office within five years (Table 1), increased awareness of the community on use of ITNs, application of indoor residual spray (IRS) use of effective drug coartem for the treatment of malaria at national and local levels, and environmental management of breeding site of the vector were undertaken (WHO, 2015; Dangila Woreda Health Bureau, 2016). .

In Dangila woreda, more than 55,414 ITN were distributed starting from 8004 in 2012 to 13432 (2016) which showed an increase by68% (Table 1). Although the increase earlier (2013-2015) was 16 - 22%. Although there was no additional ITN‟s distributed after 2015, the number of ITN

increased by the same margin of 16% in 2016 compared to 2012.indicated more people were protected by ITN in the latter years.

Table 1: The distribution of ITNs in Dangila (2012 – 2016) (Health Bureau Dangila, 2016)

Year	Prevalence of malaria	Number of ITN distributed	Percentage increase ITN
2012	20%	8004	
2013	25.9%	9350	17%
2014	13.9%	11400	22%
2015	9.1%	13228	16%
2016	9.2%	13432	The same
		55414	

4.2. Prevalence of malaria in relation to sex in Dangila from 2012-2016

The outpatients attending Dangila Health Center for malarial diagnosis and treatment slight difference between males and females in that males was 48-53% (average 50%) compared to females 47-52% (average 50%) (Table 2).Although interestingly, the population size of male and female patients attended at Dangila Health Center over the years was 50:50%. (Table 2), the

prevalence of malaria was high in males than females. Accordingly, detection of the parasites in males was 64% with compared to the females, with occurrence of 36%.

Table 2; Prevalence of malaria in relation to sex in Dangila Health Center from 2012 to 2016.

Year	Sample size					Number of positive samples to malaria					M:F ratio	P-value
	M	%	F	%	Total	M	%	F	%	Total (%)		0.18
2012	2150	53	1938	47	4088	542	66.3	276	33.7	818 (20%)	1.9:1	
2013	2972	51	2892	49	5864	926	61.1	590	38.9	1516 (26%)	1.6:1	
2014	2448	49	2504	51	4952	456	66.3	232	33.7	688 (14%)	1.8:1	
2015	1848	50	1872	50	3720	234	69.2	104	30.8	338 (9.1%)	2.3:1	
2016	1722	48	1854	52	3576	212	64.6	116	35.4	328 (9.2%)	1.82:1	
Total	11140	50	11060	50	22200	2370	64.0	1318	36.0	3688 (16.6%)	1.8:1	

Note: M= Male, F= Female, M:F= Male to female ratio.

This shows a male to female infection ratio of 1.6:1-up to 2.3: 1 with a mean of 1.8: 1 equivalent to a prevalence of 64%:36% indicating males were almost twice more vulnerable to malaria than females. The data also showed that even if there was a drastic decrease in the overall occurrence of malaria from 2013 (26%) to 9% (2016), and the vulnerability of males to malaria infection did not show any change in male: female malaria infection ratio.

The average male to female infection ratio 64%:36% of malaria at Dangila woreda was significantly higher than study in Kola Diba (53%: 47) (1.1:1) (Alemu *et al*., 2011) and from Kola Diba and Arsi Negelle (55%:45%) (1.2:1) (Mengistu and Solomon, 2015); and Mota

(57%: 43% (1.3:1) (Tilahun, 2016). All taken together that males were more vulnerable to malaria infection than females that may be associated that males in a farming and trading community engaged in activities outside their residence area (migration) which made them more prone to mosquito bites as compared to females which were limited to their resident area at home and may not be exposed to malarial areas.

4.3. Prevalence of malaria in relation to different age groups in Dangila from 2012-2016

Malaria was observed in all age groups in the area, except no infection was registered in the age group <1 year in 2014 (Table 3). Among the age groups, the most vulnerable ones was the age group of 15-44 years with the overall prevalence of (68.9%), that was almost five times more than the prevalence of the next higher infection group (age group 5-14 years) with prevalence of 14% and more than twice the infection of all the age groups combined together. In general, the data showed similar trend in malaria infection among the age groups, and all years, except that the infection rate among the age group of 15-44 years showed a significance increase in 2015 and 2016 (76-82%) compared to the previous years (65-67%). The data did not show any trend of a significant decrease and increase along the years among the different age groups, but a slight progress increase in infection of the highly infected age group (15-44 years) after 2014 (Table3).

Table 3 Prevalence of malaria in relation to different age groups in groups in Dangila from 2012-2016

Age	2012	2013	2014	2015	2016	Total	P value
<1year	18 (2.2%)	28 (1.8%)	-	2 (0.6%)	2 (0.6%)	50 (1.4%)	0.17
1-4year	46 (5.6%)	120 (7.9%)	52 (7.8%)	12 (3.6%)	18 (5.5%)	248 (6.7%)	
5-14year	126 (15.4)	220 (14.5%)	122 (17.7%)	32 (9.5%)	40 (12.2%)	540 (14.6%)	
15-44year	546 (66.7)	1022 (67.4%)	448 (65.1%)	278 (82.2%)	248 (75.6%)	2542 (68.9%)	
45-64year	74 (9%)	112 (7.4%)	58 (8.4%)	12 (3.6%)	18 (5.5%)	274 (7.4%)	
>65year	8 (1.1%)	14 (0.9%)	8 (1.2%)	2 (0.6%)	2 (0.6%)	34 (0.9%)	
Total	818 (20%)	1516 (25.9%)	688 (13.9%)	338 (9.1%)	328 (9.2%)	3688	

The male to female ratio also showed similar trends where males were more vulnerable than females, except in the age group of <1 years which showed a male to female ratio of 1:1.5 (Table 4). Thus, the highest Male to female infection was detected from the age groups of >65 years (3.2:1) followed by age group of 45-64 years with the ratio of 2.1:1, and the least was recorded from the age group of 1-14 years with a male: to female malaria infection ratio of 1:1:1 indicating that the higher the age groups are the higher the infection ratio of males vulnerable to malaria infection.

The highest prevalence of malaria (in five years) in the age group of 15-44 (68.9%) in this study was much higher than the ones recorded in Kola Diba(50%). (Alemu *et al*., 2011). However the prevalence in next high risk group of 5-14 year olds (14.6%) was slightly lower than the same in Kola Diba (19.9%) reported by the same author. The prevalence of malaria in the age group <5

years in this study was 6.7% which was much lower than the prevalence of 18.3% recorded from Motta which was the most vulnerable group for malaria infection in Mota Town (Tilahun, 2016). The reason why malaria affected productive age groups (15-44) and more males might be due to the fact that these age groups stay out door for farming and sleep under trees during night time to keep their cattle"s. Due to these and other different reasons this age groups and males were more exposed to anopheles mosquito bites, which can transmit malaria parasites.

Table 4 Pattern of infection between males and females amongst the age groups infected with malaria in Dangila woreda from 2012-2016 years

Age groups	Malaria infected Groups		Male: female ratio
	Male	Female	
<1 years	40%	60%	1:.1.5
1-14 years	52%	48%	1.1: 1
15-44 years	59%	41%	1.4:1
45-64 years	68%	32%	2.1:1
>65 years	76%	24%	3.2:1
Average	58%	42%	1.4:1

4.4. Prevalence of *Plasmodium* species in Dangila from 2012-2016

The pattern of infection by different species of malarial parasites showed that 69% of the patients were infected by *P. vivax* followed by 31% infection with *P. falciparum* (Table 5). Both *P. vivax* and *P. falciparum* infected males more than twice more males than females (44%:25%) and (20%:11%), respectively. The pattern of pathogenic infection show difference across the period of infection ranging from the highest 82%:18% *P. vivax: P .falciparum* infection in 2012 to the lowest infection of 62%:38% ratio of in 2013.

Table 5: Pattern of plasmodium infection the population diagnosed for malaria at Dangila Health Center from 2012 to 2016.

Year	Malaria positive			*Plsmodium vivax*			*Plasmodium falciparum*		
	M	F	T	M	F	Total	M	F	Total
2012	542	276	818	53%	29%	82%	13%	5%	18%
2013	926	590	1516	37%	25%	62%	24%	14	38%
2014	456	232	688	46%	22%	68%	20%	12%	32%
2015	234	104	338	52%	24%	76%	17%	7%	24%
2016	212	116	328	41%	26%	67%	23%	10%	33%
Total	2370	1318	3688	44%	25%	69%	20%	11%	31%

Note: M= Male, F= Female, T= Total

The dominance of *P. vivax* was also reported from the survey made in the Oromia Region from1995-2000 where *P. vivax* accounted to 51.9% of cases compared to 32.3% infection by *P. falciparum.* (Ahmed, 2006). Similarly, a study conducted in Jimma town in September 1994 showed 3,424 malaria patients cases of which *P. vivax* accounted for 58.4%,where as *P. falciparum* accounted for 30% of the cases and the remaining 11.6% was mixed infection, which shows that the dominance of *P. vivax* (Shiferaw,1994). Woyessa *et al*. (2012) also showed the dominamce of *P. vivax* from Butajira and surrounding areas in that, 86.5% of the patents were positive to *P. vivax* compared to 12.4% for *P. falciparum* and the remaining 1.1% showed mixed infection.

The prevalence of malaria in other places; showed different pattern and dominance of *P. falciparum* over *P. vivax* to the tune of 75%:25% in Kola Diba Health Center from 2002 to 2011, (Alemu *et al*., *20011*), and 61%: 34% in Mota Town (Tilahun, 2016). In general the study difference in the prevalence and specific malaria species in this study and the study conducted at different place mentioned above might be due to variation in the study area. It is interesting to note that although *P. falciparum* is the dominant prevalent species accounting to 60% of the malaria cases in the country (FMoH, 2007), that is not the case in Dangila area. And *P. vivax* are the most dominant malaria parasites in Dangila. They are prevalent in the malarious areas in the country and their relative composition generally is 60% and 40% of the malaria cases respectively.

The possible reason for this shift from *P. falciparum* to *P. vivax* might be due to the public health importance of *P. vivax* that is frequently overlooked and left in the shadow of the enormous problem caused by *P. falciparum*. In addition the prevention and control activities of malaria as guided by the national strategic plan mainly focus on *P. falciparum* because it is assumed to be

more prevalent and fatal malaria in the country Ethiopia. Other possible reason might be *P. vivax* might have developed resistance for the currently used drugs, and other possible reason might be *P. vivax* can relapse after treated (FMoH, 2007).

4.5 Seasonal variation of plasmodium species in Dangila from 2012-2016

In the study area malaria was observed in almost every season of the years. Although there was significant fluctuation in the number of malaria cases, the highest prevalence of malaria cases was observed between September and November (37%) followed by summer (Jun, July and August) (27%), while low slide positive rate occurred between March and may (16%) (Table 6). This is in agreement with other studies done in kola Diba Health Center in which malaria transmission peaks from September to November (Alemu *et al*., 2011).

Table 6: the distribution of malaria parasite in different seasons from 2012-2016

Plasmodium species	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug	Total
P. falciparum	476 (42%)	216 (19%)	193 (17%)	249 (22%)	1134 (30.7%)
P.vivax	894 (35%)	511 (20%)	383 (15%)	766 (30%)	2554 (69.3%)
Total	1370 (37%)	727 (20%)	576 (16%)	1015 (27%)	3688
P vivax: P falciparum ratio	1:1.2	1.1:1	1:1.13	1.4:1	2.3:1

Similarly, the highest peak of almost 40% of malaria cases was recorded between September and November months in all years followed by 26% of infection during the months of June to

August and the minimum number of malaria cases was observed during the months of March to May (15.5%) in Motta town (Tilahun, 2016).

Although the overall pattern of infection showed the dominance of *P. vivax*, interestingly, the months of September-November and march-May showed the maximum number of cases of *P. falciparum* (Table 6). Similar fluctuation infection by *P. vivax* and *P. falciparum* was also detected from Mota Town (Tilahun, 2016).

Table 7: prevalence of malaria parasites in Dangila in relation to other studies in Ethiopia

Sample size	Prevalence of malria	*P.falcifarem*	*P.vivax*	mixed	Reference
Dangla health center	16.6%	31.0%	69.0%	__	This study
Koladiba	39.6%	75%	25%	__	Alemu *et al.* (2011)
Jimma town	6.3%	30%	58.4%	11.6%	Shiferaw. (1994)
Butajira	0.93%	12.4%	86.5%	1.1%	Woyessa *et al.* (2012)
Motta	11.53%	60.9%	34.1%	5%	Tilahun. (2016)

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

- The prevalence of malaria was recorded in Dangila town ranging from the highest infection of 25.9% in 2013 to that of 9.1% (2015).
- The data showed a 42% and 65% decrease in malaria infection in the study area in 2015/2016 years compared to the years of 2012 and 2013, respectively.
- The data also showed more males were infected with malaria than females to the tune of 64%%:36% which was one of the widest range between the sexes compared other works.
- There was also a different pattern of infection among the age groups in that the active age groups of 15-44 years and 5-14 years were more vulnerable to malaria infections evidenced by the prevalence of 68.9% and 14.6% respectively.
- In relation to the type of species that infected the population, *P. vivax* was the dominant parasite with prevalence of 2,554(69%) followed by *P. falciparum* with prevalence of 1,134(31%).
- The highest peak of 37% of malaria cases was recorded between September and November months followed by 27% of infection during the months of June to August and the minimum number (16%) of malaria cases was observed during the months of March to May.
- Although the overall pattern of infection showed the dominance of *P. vivax*, interestingly, the months of September-November and March-May showed higher number of P. *falciparum* cases.

5.2. Recommendation

- This is a secondary clinical data which was prone to many fluctuations, misdiagnosis. Consequently, there is a need for a comprehensive study based on primary data and taking blood from random samples from towns and rural areas to have a clear picture of the prevalence of the disease.
- On the spot surveillance and collection of data is necessary to verify interventions that had been made with local and international efforts through the use of IRS (indoor-residual spraying), ITNs and modern drugs actually reduced the prevalence of malaria in the study area in accordance to the five-year national Strategic Plan for Malaria prevention, Control and Elimination.

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Appendix

Table : Prevalence of plasmodium species infect the population diagnosed in Dangila Health Center from 2012 to 2016.

Year	Malaria positive			*Plasmodium vivax*						*Plasmodium falciparum*					
	M	F	T	M	%	F	%	T	%	M	%	F	%	T	%
2012	542	276	818	432	64.5	238	35.5	670	81.9%	110	74.3	38	25.7	148	18.1%
2013	926	590	1516	560	59.4	382	40.6	942	62.1%	366	63.8	208	36.2	574	37.9%
2014	456	232	688	314	67.7	150	32.3	464	67.4%	142	63.4	82	36.6	224	32.6%
2015	234	104	338	176	68.8	80	31.2	256	75.7%	58	70.7	24	29.3	82	24.3%
2016	212	116	328	136	61.3	86	38.7	222	67.7%	76	71.7	30	28.3	106	32.3%
Total	2370	1318	3688	1618	63.4	936	36.6	2554	69.3%	752	66.3	382	33.7	1134	30.7%

Tabel;Prevalence of malaria with respect to Age groups from 2012-2016

Month	Sex	<1	1-4	5-14	15-44	45-64	>64
Sep	M	3	18	45	242	25	4
	F	2	12	31	100	29	1
	T	5	30	76	342	54	5
Oct	M	2	15	43	245	26	2
	F	3	13	33	104	31	1
	T	5	28	76	349	57	3
Nov	M	2	19	30	130	17	6
	F	2	11	12	98	9	1
	T	4	30	42	228	26	7
Dec	M	2	2	34	181	15	3
	F	2	2	18	67	9	1
	T	4	4	52	248	24	4
Jan	M	1	6	14	114	6	1
	F	1	5	16	56	5	1
	T	2	11	30	170	11	2
Feb	M	3	3	14	82	3	1
	F	2	2	11	39	1	1
	T	5	5	25	121	4	2
Mar	M	1	5	14	15	5	1
	F	2	6	7	25	2	1
	T	3	11	21	40	7	2
Apr	M	2	6	8	54	4	1
	F	2	9	8	28	2	1
	T	4	15	16	82	6	2
May	M	2	13	30	173	18	1
	F	2	14	25	72	13	1
	T	4	27	55	245	31	2
Jun	M	2	15	36	234	12	1
	F	2	13	34	92	16	1
	T	4	28	70	326	28	2
Jul	M	1	10	20	108	4	1
	F	5	16	15	48	2	1
	T	6	26	35	156	6	2
Aug	M	1	14	30	154	11	1
	F	4	16	12	81	9	1
	T	5	30	42	235	20	2

Table: Prevalence of malaria in relation to different age groups in Dangila health center from 2012 to 2016.

year	<1 year				1-4 year				5-14 year				15-44 year				45-64 year				≥ 65 year			
	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%
2012	6	12	18	2.2	32	14	46	5.6	78	48	126	15.4	388	158	546	66.7	32	42	74	9	6	2	8	1.1
2013	12	16	28	1.8	60	60	120	7.9	114	106	220	14.5	666	356	1022	67.4	64	48	112	7.4	10	4	14	0.9
2014	-	-	-	0	26	26	52	7.8	82	40	122	17.7	310	138	448	65.1	30	28	58	8.4	8	-	8	1.2
2015	2	-	2	0.6	4	8	12	3.6	22	10	32	9.5	194	84	278	82.2	10	2	12	3.6	2	-	2	0.6
2016	-	2	2	0.6	6	12	18	5.5	22	18	40	12.2	174	74	248	75.6	10	8	18	5.5	-	2	2	0.6
total	20	30	50	1.4	128	120	248	6.7	318	222	540	14.6	1732	810	2542	68.9	146	128	274	7.4	26	8	34	0.9

Declaration

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

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Statement of the supervisor(s)

This Thesis has been approved for submission to the Department of Zoological Sciences for public defense.

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