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Addis Ababa University

PAST-EIGHT YEAR TREND AND CURRENT STATUS OF MALARIA PREVALENCE IN KUERGANG TOWN, NUER ZONE, GAMBELLA

By

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Advisor

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Declaration

I the undersigned, declare that this thesis is my own original work and it has not been presented in other university for similar degree or other purpose

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Name Date of Submission Signature

Supervisor Statement

I, the Undersigned, Confirm that this thesis is approval for Submission.

Dr Hassen Mamo ____________________ ____________________

Name Date Signature

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Abstract

Malaria is one of the major public health problems worldwide. In Ethiopia there is significant decline in disease burden, however the overall trend of malaria prevalence is not studied or not documented in different locality. The aim of this study was to analyses the past eight years and current status of malaria prevalence in Kuergang town, Nuer zone, Gamblla. Retrospective laboratory record review was conducted in Kuergang health center (2011 to 2018), which was carefully reviewed from September, to December. In this study the prospective data from September 2018 to February 2019 was also analyzed. Patients visiting the health center between September 2018 and February 2019 were successively recruited .Blood samples were drawn and examined by following standard procedures. A total of 10850 examined blood films were prepared and examined from malaria suspected patients at Kuergang health center. Of the examined blood films 5223(48.1%) were confirmed as RDT positive. The trend of malaria prevalence in the study seems slightly fluctuated. Malaria cases were higher in males 2963(56.7%) than 2260(43.3%) females. P. falciparum and p. vivax were accounted for 3804(72.8%) and 925(17.7%) respectively. From the total positive cases 494(9.5%) were mixed (*P-falciparum and P. vaivax*).In the prospective study a total of 2808 suspected cases of malaria were reported at Kuergang health center. Of this 924(33.0%) were RDT positive. Among these positive cases 526 (57.0%) and 398(43.0%) were males and females respectively. Higher number of malaria cases was observed in >18 age category. There was higher percentage 750 (81.1%) of *p. falciparum* infection than *p. vivax* 106 (11.5%) and mixed 68(7.4%) cases. In prospective study there was peak malaria transmission period in September 201(58.9%) and October 249(39.7%).From June to September malaria prevalence was high in the past eight years. This study showed that more males were infected with malaria in retrospective study. P. *falciparum* was the dominant parasite in both retrospective and prospective study. Seasonal variation should be well recognized with special focus given to annual peak seasons (months), to prevent high malaria transmission.

Keywords:-Prevalence, Kuergang, prospective, retrospective, malaria, P. falciparum, P.vivax

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Acronyms

ACT..Artemisinin based Combination Therapies

ALF..Artemether Lume fantrine

CDC ....Centers of Disease Control and Prevention

CSA..Central Statistical Agency

DDT ....Dichloro Diphenyl Trichloro Ethane

DHS..Demographic Health Survey

EHNRI ....Ethiopian Health and Nutrition Research Institute

FMOH...................................Federal Ministry of Health

HCs ....Health Centers

HEWs.....................................Health Extension Workers

HF ....Health Facility

HPs...Health Posts

IRS ....Indoor Residual Spraying

ITNs ....Insecticide Treated Nets

MIS ....Malaria Indicators Survey

MOP.......................................Malaria Operation Plan

NMCP-----------------------------National Malaria control program

PCR----------------------------------Polymerase chain reaction

PMI…………………………President Malaria initiative

RDT…………………………Rapid Diagnostic Test

SPSS......................................Statistical Package for Social Sciences

SSA.......................................Sub Saharan Africa

UNICEF................................United Nations International Children’s Fund

USAID ....United States Agency for International Development

WHO.....................................World Health Organization

1. Introduction
1.1 Back ground
Although malaria incidence is reduced by 37% globally and by 42% in Africa between 2000 and 2015, the disease remains a formidable public health threat. It is estimated that there were 214 million clinical cases and 438000 deaths in 2015 due to malaria (WHO, 2015). Malaria is an infectious disease of man and animals. The causative agents of malaria are picomplexan protozoa of the genus *Plasmodium*. There are five different *P* species are known to cause infection in humans. These are *P*, falciparum, *P. vivax, P. ovale, P. malariae and P.knowlesi*. Most of malaria cases and deaths are caused by P.*falciparum* and P.vivax. While *P.faciparum* mostly predominates in Africa, P.vivax cases are distributed more frequently in Asia, Latin America and some areas of Africa (Darymple *et al*, 2015) malaria is transmitted through the bite of infected female anopheles mosquitoes. When an appropriate infected mosquito species bites the plasmodia (sporozoite stages) cross peripheral circulation and after a while enter hepatocytes. The sporizoites undergo multiple fission forming schizonts that later release merozoites which migrate to the peripheral blood circulation once again and infect erythrocytes. Inside the erythrocytes the parasites multiply eventually resulting in the rupture of the host cells.

Combating malaria was among the eight millennium development goals. Early diagnosis and effective treatment, vector control, easy and universal accessibility to bed nets, residuals periodic spray of dwellings, environmental management and continued efforts in epidemic prevention control strategies that are currently being implemented in most malaria endemic areas (Sheleme,2007).

Malaria is one of Ethiopia's foremost health problems. About 60% of its population lives in malarious areas and 68% of its landmass is favorable for malaria transmission. Malaria transmission and clinical cases in Ethiopia after the main rainfall season, July to September, each year. However, many areas in south and west of the country have a rainfall season beginning earlier in April and May or have no clearly defined rainfall season (FMOH, 2014). Consequently, malaria transmission tends to be highly heterogeneous within each year as well as between years. A relatively long transmission season exists in the western low land areas, river, basins, valley, and irrigation schemes.

Due to the unstable and seasonal transmission of malaria, protective immunity is generally low and all age groups of the population are at risk of the disease. Malaria in Ethiopia is characterized by widespread epidemics occurring every five to eight years, with the most recent epidemic occurring in 2003/2004 (FMOH, 2004). In 2014/2015, the total number of laboratory confirmed plus clinical malaria cases were 2,174,707.Of those cases 1,867,059(85.9%) were confirmed by either microscopy or rapid diagnostic tests (RDT) out of which 1,188,627(63.7%) were *P. falciparum* and 678,432(36.3%) *P.vivax* (FMOH, 2008).

The NMCP formulated a goal to reduce morbidity and mortality due to malaria through scaling-up and sustaining the coverage of key malaria interventions. In this plan, areas below 2000m above sea level were generally classified as malaria's and considered eligible for intervention. The National Strategic Plan for malaria control and prevention in Ethiopia 2006- 2010 aimed to rapidly scale-up malaria control interventions to achieve a 50% reduction of the malaria burden, in the line with global roll back malaria partnership objectives (EHRI, 2012).

The status of coverage of the major interventions was measured in the malaria indicator survey. The MIS 2007 results show tremendous achievements by Ethiopians malaria control program. Thus, between 2005 and 2007 ITNs coverage increased 15 fold, with ITN use by children under five years of age and pregnant women increasing to early 45% in malaria- endemic areas and to over 60% in households that owned at least one ITN. Overall, 68% of households in malaria endemic areas were protected at least by One ITN and IRS. It is believed that the vector control interventions have contributed greatly to a reduction in the burden of the disease more than 20 million long-lasting insecticidal nets (LLINs) have been distributed to 10 million households between 2005 and 2007. With respect to IRS activities, evidence shows that 30% of IRS-targeted areas were sprayed in 2007 and in 2008 the coverage increased to 50%. So far, the main vector control activities implemented in Ethiopia include: IRS, LLINs and mosquito larval source reduction. The malaria vector control guidelines also addresses vector control interventions found to be effective in past decades. The insecticides commonly used in the country include dichloro-diphenyl-trichloroethane (DDT), malathion and deltamethrin (Balkew *et al*, 2010).

According to the EMIS, 2015 the trends showed that in LLIN use by all house hold members, children under five years old and pregnant human living in malarious areas in 2007, 2011 and

2015.There have been slight increase in LLIN use among children under five and pregnant human (38% and 35%) in 2011 compared with 45% and 44% in 2015). However, the use of LLIN by thus population groups is almost similar. Moreover, the trends in malaria parasites prevalence since 2007 by RDT and microscopy in malaria's areas. There were a reduction in malaria prevalence by RDT in 2015 (1.2%) compared to in 2011 (4.5%).Similarly, when comparing the microscope results, malaria prevalence in 2015 is lower than that of 2007 and 2011 (FMOH, 2015).

Due to resistance of malaria vectors to DDT, the use of this insecticide for IRS has been discontinued in 2009. Deltamethrin is currently being used as an interim substitute insecticide for DDT in IRS operations (Abate, 2011). However, the selection of insecticides for indoor insecticidal residual (IRS) use in Ethiopia will be determined annually based on the insecticide resistance pattern of vectors another factors. Recently the propoxur or bendiocarb are in use as per the WHO recommendation (http: //www.who. int/whopes/Insecticides-IRS-2-March-2015.Pdf?ua=1.

As outlined in the NSP 2011-2015, Ethiopia has a target of 100% access to effective and affordable malaria treatment. This requires improving diagnosis of malaria cases using microscopy or using multi-species rapid diagnostic techniques (RDTs), and providing Prompt and effective malaria case management at all health facilities in the country. Thus malaria diagnosis and treatment are essential components of anti-malaria interventions in the country (EPHI, 2012).

Artimisinin combination therapies are the first-line drug for treatment of uncomplicated *P. faciparum* malaria in Ethiopia since 2004 (FMOH, 2008). Oral quinine is used as the first-line treatment for pregnant women during the first trimester and for children of less than 5kg chloroqunine is used for treatment of *P.vivax*. Radical cure with primaqunine is recommended for patients with *P. viviax,* residing in non-malaria endemic areas that are treated at the health center or hospital levels (Alemu *et al*, 2013). Primaqunine is not currently recommended at health post level because the prevalence of glucose-phosphate dehydrogenate deficiency is not known in Ethiopia. As a result, it is difficult to detect and manage complications of primaqunine at this level. Artemether-lumefantrine is used for mixed infections due to both *P. falciparum* and *P.vivax.*

Sufficient resources have been secured, through the Global fund, World Bank, US President's Malaria Initiative (PMI) and others to support universal coverage of key malaria interventions by the end of 2010. Thus, Ethiopia will move from scaling-up for Impact to sustained control, as key steps in the process toward, malaria elimination by 2020 (PMI,2016). In the coming years, Ethiopia will need to build on and sustain tremendous progress that has already been made, ensure that the quality of the services delivered is high, and will need to further strengthen some key areas such as IRS, diagnosis and rational drug use, and surveillance including epidemic surveillance and response. These steps will form part of the roadmap in preparation for pre elimination by 2015, geographical elimination especially in areas of historically low transmission (FMOH, 2004).

The 2011-2015 NSP will focus on sustained control and moving towards malaria elimination through an integrated community health approach, especially in areas of unstable malaria transmission, building on SUFI achieved by the 2005-2010 strategic plan (FMOH, 2011)..

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 Kuergang town 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 Kuergang town. 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. Malaria remains to be the major public health problem challenge in Gambella region, of this Lare woreda is one of malaria risk area. Thus it is very essential in which the research is conducted, to determine the prevalence of malaria in Kuergang town Lare woreda and also it is very essential to provide information for the concerned body in order to apply malaria control and prevention action.

1.3 Research questions

1. What was the level of the past-eight year's trend and current prevalence of malaria in Kuergang town?
2. Which season was mostly high in the prevalence of malaria infection in the study area?
3. Which species of plasmodium is highly prevalent in the study area?
4. What was the sex relation and age category of malaria occurrence in the study area?

1.4 Significance of the study

Information on the number and distribution of malaria cases and deaths is critical for monitoring malaria status in a locality and making possible adjustments in malaria control efforts. It is needed to determine which areas or population groups are most affected by malaria, so that resources can be targeted to the populations most in need. Information on the prevalence of disease in relation to past levels is needed to alert programs about epidemics, so that control measures can be intensified. Data on changes in disease incidence and mortality are also required in order to judge the success of a programme and to determine whether it is performing as expected or whether adjustments in the scale or blend of interventions are required. In light of this a number of studies at different parts of Ethiopia have been conducted and are currently underway.

The present study was therefore, aimed at estimating the prevalence and current status of malaria in kuergang town over the past eight years' period, and also the current status of malaria burden on the community at Kuergang health center. The study is expected to be scientific evidence usable by local and national policy makers and program planners for assessing malaria control progress and focusing future efforts.

1.5 Objectives

1.5.1 General objective

- To analyze past eight years prevalence and current status of malaria in Kuergang town Nuer zone, Gambella region.

1.5.2 Specific objectives

The study had the following specific objectives. It was to:

- To show the specific prevalence of yearly and monthly pattern of malaria in Kuergang Town.
- Identify plasmodium species distribution in Kuergang town health center.
- Evaluate age, sex, and seasonal distribution of malaria in Kuergang town health center.

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*, *P. vivax,* p. ovale and *P. malariae* generally cause a milder form of malaria. The species *P. knowlesi* rarely causes disease in humans (Geleta and Ketema, 2016). About 3.2 billion people almost half of the world 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 places (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 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 P.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 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. Global 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 whereas 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 1.8 %(WHO, 2015).

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. In Ethiopia *P. vivax* may be co-dominant with *P. falciparum* although marked spatial and temporal variations are noticed (Yimer *et al,* 2015). Malaria transmission peaks biannually from September to December and April to May, coinciding with the major harvesting seasons. This has serious consequences for Ethiopia's subsistence economy and for the nation in general.

2.3. Malaria Status in Gambella

Gambella is characterized by high malaria transmission due to its suitable climate and high rainfall. P. *falciparum* and *P. vivax* contribute to most of the malaria cases of the general population and Anopheles gambiae and Anopheles pharoensis are the primary mosquito vector species (FMOH, 2006). Some small-scale studies have documented on malaria parasite prevalence in Gambella is between 10.4–13.5%. In addition to seasonal pattern of malaria transmission in Ethiopia especially in Gambella region anthropogenic factors are also contributing to the spread of malaria. These include population growth and movements, urbanization, water development schemes, agricultural development, conflicts and improper use of drugs and the attendant consequences of the emerging drug-resistant malarial parasites, deforestation poor housing, lack of proper sanitation, poor drainage of surface water, weak health services and wide-spread economic unequal, which independently or together facilitate malaria transmission and establishment of new settlements in previously unsettled areas. These allow making comfortable for the proliferation of mosquitoes that prefer human habitation to natural settings (Bayissa, 2007, Yaya, 2011, Alemu et al., 2011).

2.4. 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 oocytes. 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, ten 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 lymphatic, and some others find a blood vessel (Ashley *et al*, 2008).The sporozoites that enter lymphatic vessel reach the draining lymph node 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 an 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-erythrocyte phase lasts about 5-16 days depending on the parasite species on an average 5-6 days for P.*falciparum,* 8 days for P.*vivax,* 9 days for *P. ovale*, 13 days for *P. malariae* and *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 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 RBC (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 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 disorders 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 tube vesicular network, 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). As the parasite grows and multiplies with in red blood cell the membrane permeability and cytosolic composition of the host cell is modified (Virgilio et al., 2003).

These new infusion 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 sunbridled 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 anopheles mosquitoes, where in they continue the sexual phase of the parasites life cycle.

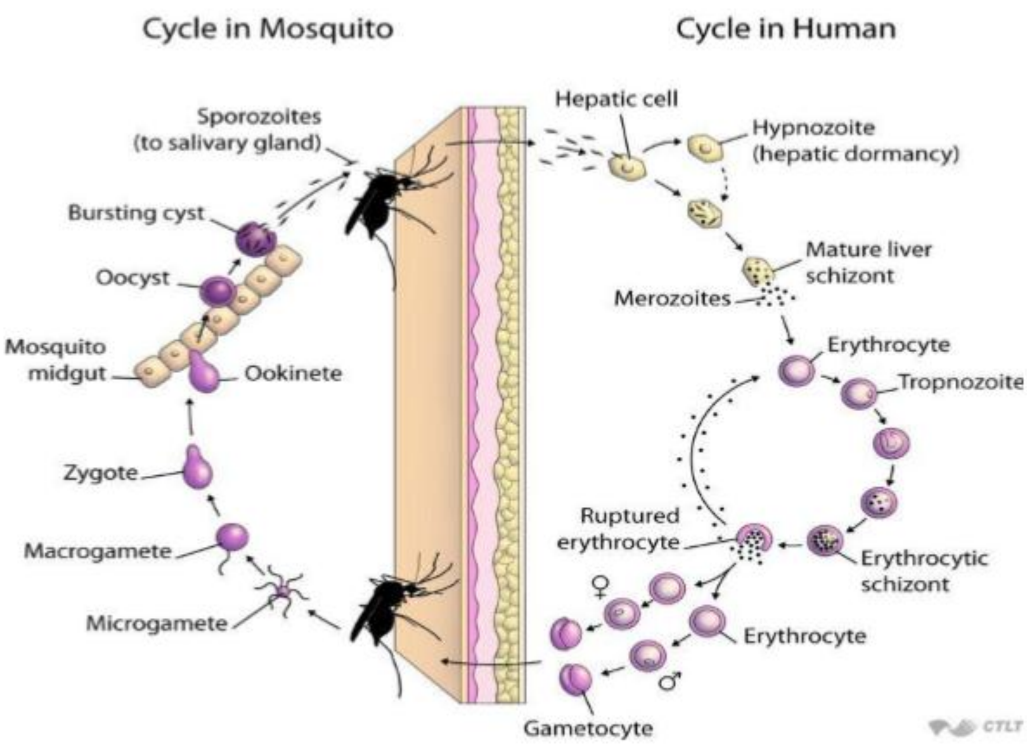

Figure 1 The life cycle of malaria parasites (source: htt://ocw.jhsph.edu).

2.5. Symptoms of malaria

The sign 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, and 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, severe anemia and bleeding. Acidosis and hypoglycemia are the most common metabolic complications. 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 reactivation 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. Deterioration 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. *falciparum* .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 for 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. Rapidly, even after initial response to anti-malarial handling and clearance of parasitemia. The first indication of impending pulmonary edema includes tachypnea and dyspnea, followed by Acute renal failure is usually oliguric (< 400ml/day) or anuric (<50ml/day), rarely non oliguric and may require temporary dialysis. Urine residue refers to passage of dark red, brown, or black urine secondary to massive intravascular hemolysis usually is not remarkable.

Malaria infection develops via two phases: one that involves the liver (exoerythrocytic phase) and one that involves red blood cell or erythrocytes (erythrocytes 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 erythrocyte stage of the life cycle (Bledsoe, 2005).

The parasite escapes from the liver undetected by packaging 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 *P. 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 obstruction of the micro vasculature causes symptoms such as in placental malaria

Repossessed red blood cells can breach the blood-brain barrier and cause cerebral malaria (Renia *et al*, 2012).

2.6. 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 delivered some resistance to it including sickle cell trait, thalassemia traits, glucose-6-phosphate dehydrogenase deficiency, and the absence of Duffy antigens on red blood cells (Kwiatkowski, 2005)

The influence 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 stand 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).

2.7. 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). *P. 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 (For molecular methods below) or monoclonal antibody panels that can distinguish between the two should be used in this part of the world (*Cutchen et al,* 2008).

2.8. 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 electrolyte. 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 and 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 three fold greater anti-malarial activities than does quinine, but it is also more cardio toxic and mandates electrocardiographic monitoring (White, 1999).

2.9. 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).

P. falciparum 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). 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).

2.10. 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. 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 fore 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).

3. Materials and Methods

3.1. Study Area

The study was conducted in Kuergang town Lare woreda of Gambella region. The Gambella people's National Regional state is located in the extreme western part of Ethiopia covering an area about 34,063 km^2. The Region is bordered in the north by Benishangul Gumuz and Oromiya states, in the South by Southern Nation's Nationalities and People's Region and in the east by Oromiya and South Nation's Nationalities and people's Region and in the west by the Republic of South Sudan. From the point of grid reference, the region is located between 7^0 N to 8^0 N latitude and 33^0E to 35^0 E longitude. Gambella town is the administrative center of Gambella Regional State and is located in the southwest Ethiopia at about 777 km from Addis Ababa. Lare woreda is located in the north western part of the Gambella region and it is located 85km away from the Gambella town. Lare woreda is characterized by high malaria transmission due to its suitable climate, humidity, hot and high rain fall areas of Ethiopia. This area is commonly affected by *P. falciparum* and next by *P. vivax. P. falciparum* is the predominant species in lare woreda where it is responsible for mony malaria cases. According to Lare woreda report malaria transmission peaks from September to December and from June to August. This woreda has only one governmental health center in Kuergang town that gives service for the patients. Based on 2007 census conducted by Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 31,406. Of this 16,145 are males and 15,261 females. This retrospective and prospective study of malaria prevalence was conducted in Kuergang health Centre Lare woreda (Figure 2).

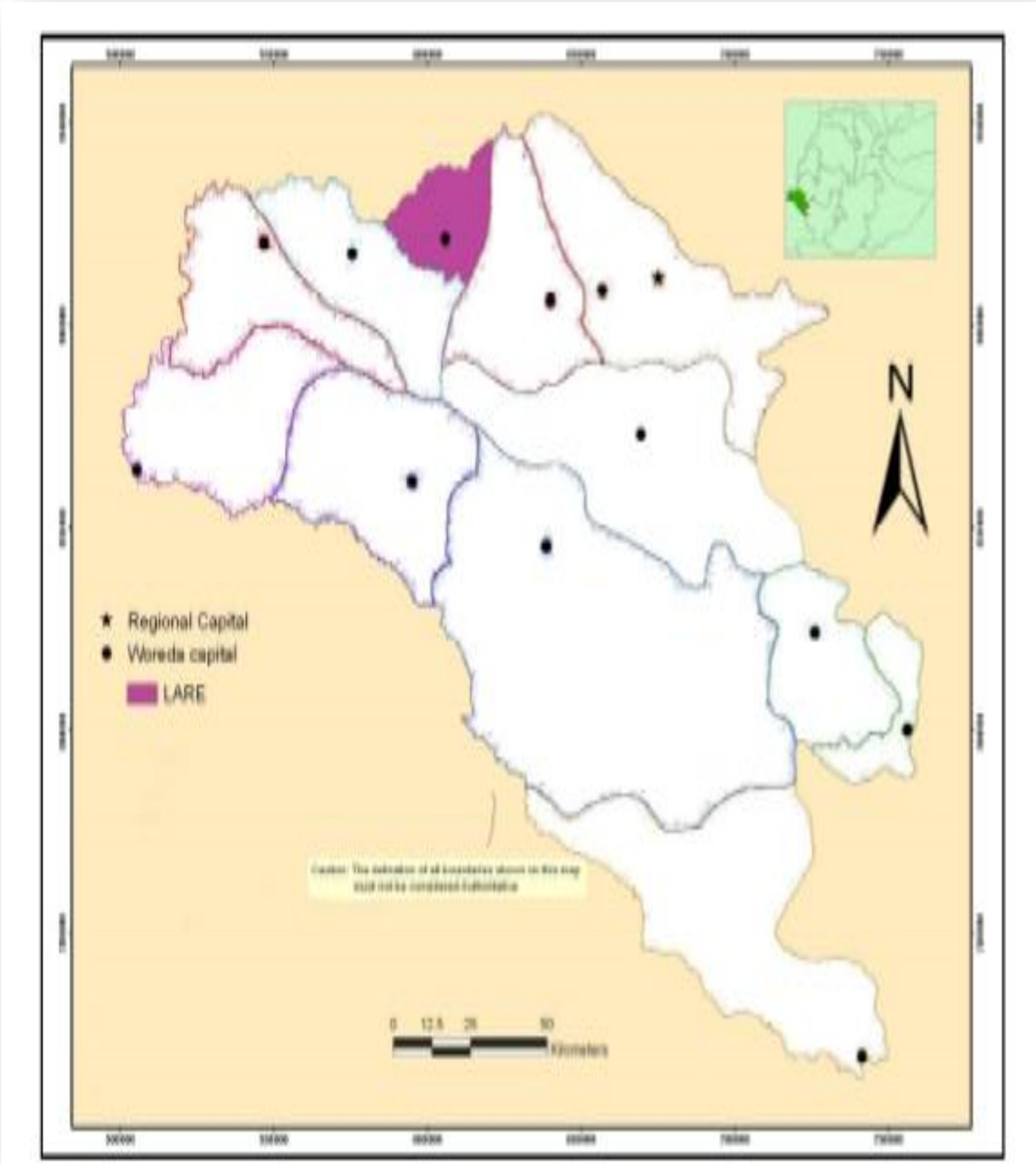

Figure 2 Location of Lare woreda within Gambella Regional State. (ISSN 2321 – 919X) w www.theijst.com

3.2 Study Design and Population

The study design was health facility-based cross-sectional survey carried out from September 2018 to January 2019 (prospective). Past eight-year (2011-2018) malaria trend in Kuergang town Lare woreda was also evaluated (retrospective). All febrile patients showing malaria symptoms were involved in prospective study. The common symptom of malaria may include headache, fever, shivering, joint pain, vomiting and retinal damage. Both males and females found in all age groups were examined. The attending patients categorized in to <5, 5-18 and>18 age groups involve for both retrospective and prospective study.

3.3 Blood Sample Collection and Analysis

Febrile patients at Kuergang health center emergency or outpatient department were examined by attending health personnel and invited to participate in the current study. Careful procedures were adopted in the collection of finger-prick blood samples by swabbing the area by swab alcohol and allowed to dry before collection. Once the patient's finger is dry, open the lancet and prick the finger. Then collect correct amount of blood (5µl) by capillary tube. Thin blood films were made on clean Rapid Diagnostic Test (RDT) cassettes and labeled accordingly for later observation. Wait for the correct duration of time (15 minutes) after adding buffer before reading test result. The test window (cassette) contains control line, *P. falciparum* line and *p.vivax* line. The name, age, sex and number of subjects marked carefully on the RDT cassette. Different possible results were examined by experienced laboratory technician at the health center. The positive and negative results have been recorded under the check list separately. Any patients found to be infected with *P. falciparum* were treated with Coartem, and patients infected with *P. vivax* were treated with chloroquine according to national malaria treatment guidelines.

3.4 Retrospective data collection

An 8 years (2011–2018) retrospective data on malaria prevalence was collected from September to December 2018 at Kuergang health center and health office. Data were taken from the primary record book of the health center.

3.5 Prospective data collection

In this health center, peripheral smear examination of blood by RDT test has been used as the gold standard in confirming the presence of malaria infection for prospective study. The data were collected from September 2018 up to the end of February 2019. All malaria patients attending at Kuergang health center were used for prospective data.

3.6 Data quality control

The retrospective data were taken from the primary record book of the health center. For the prospective data information of every member of the patient was registered during their visit to the health center within the study period. Professional health workers collected the data independently and cross cheeked each other and record each of malaria suspected patients as malaria positive and malaria negative separately.

3.7 Data Analysis

Data were checked for consistency and completeness and analyzed. The chi-squared test was used to determine difference between years, seasons (months), age, and sexes as well Malaria parasite distribution for both retrospective and current cross-sectional data. Qualitative techniques were employed in the computation of statistical tables, charts and statements. The data were entered in Microsoft Excel data sheets, cross checked and transferred, and analyzed using SPSS 23 software package among the different age groups, sexes, species distribution and seasonal variation over time. P-values <0.05 were considered to be statistically significant.

3.7 Ethical Consideration

This study was approved by Department of Zoological Science in Addis Ababa University and supporting letter was obtained from Addis Ababa University. The participants were clearly informed about the nature and aim of the study and told that their participation was voluntarily. They gave written consent to take part in the study after adequate explanation about the significance of the study. Blood samples were collected by qualified laboratory technicians and malaria-positive participants got appropriate treatment by the health professionals.

4. Results

4.1 Retrospective malaria prevalence

4.1.1 Annual prevalence of malaria in the study area by sex

A total of 10850 malaria suspected patients were collected and tested for malaria diagnosis at Kuergang health center from 2011 up to 2018. Of which 5223(48.1%) of the test sample were microscopically confirmed as malaria cases (Table1). According to this study the prevalence of malaria was high, which recorded from 2011-2018. In 2016 and 2012 the highest malaria prevalence 70.1% and 70.5% were recorded respectively. The lowest malaria prevalence was observed in both 2018 (22.0%) and 2017 (32.0%). But in 2013 and 2014 the prevalence of malaria was, relatively similar which were covered 65.5% and 65.6% respectively. In the study the cumulative prevalence of malaria out of the total examined patients on the past eight years was 48.1%. There was no a significant statistical difference in the prevalence of malaria throughout the year.

Table 1 Annual prevalence of malaria from 2011 to 2018 in Kuergang town health center by sex

Year	Total examined(n)%	Total slide positive, (n)%	Male slide positive (n)%	Female, slide positive(n)%	P⁻ Value
2011	1500(13.8)	774(51.6)	394(50.9)	380(49.1)	
2012	1200(11.1)	842(70.1)	510(60.6)	332(39.4)	
2013	950(8.8)	622(65.5)	350(56.3)	272(47.7)	
2014	800(7.4)	525(65.6)	290(55.2)	235(44.8)	
2015	1500(13.8)	705(47.0)	430(70.10)	275(39.0)	
2016	1000(9.2)	705(70.5)	435(61.7)	270(38.3)	
2017	1800(16.6)	580(32.2)	254(43.8)	326(56.2)	
2018	2100(19.4)	470(22.4)	300(63.8)	170(36.2)	0.38
Total	10850(100)	5223(48.1)	2963(56.7)	2260(43.3)	

* p value determine the overall malaria prevalence throughout the year with sex variation

4.1.2 Annual prevalence of malaria in relation to sex and Plasmodium species distribution

From the total malaria examined patients 2963(56.7%) were males malaria positive and 2250 (43.3%) were females malaria positive (Table 1). The prevalence of malaria among sex did not have statistically significant difference (p >0.05).

As shown in (Table 2) *P. falciparum*, *P.vivax* and mixed case were the major causative agents for malaria infection in the study area. Regarding to the identification of species, the three cases were reported in the eight years. *P.falacioprum* is the dominant species over both *P.vivax* and mixed cases. From the total malaria confirmed patients 3804(72.8%, 925(17.7%) and 494(9.4%) cases were accounted for *P.falaciprum*, *P.vivax* and mixed cases respectively. The difference was statistically significant (p<0.05) which is 0.001.

Table 2 Annual distributions of Plasmodium species in Kuergang health center

Year	Total examined(n)%	Total slide positive(n)%	*P.falciparum* positive(n)%	*P.vivax* positive(n)%	Mixed infection(n)%	p-value
2011	1500(13.8)	774(51.6)	507(65.5)	175(22.6)	98(12.7)	0.001
2012	1200(11.1)	842(70.1)	606(72.0)	146(17.3)	80(9.5)	
2013	950(8.8)	622(65.5)	447(71.9)	114(18.3)	66(10.6)	
2014	800(7.4)	525(65.6)	387(73.7)	95(18.1)	41(7.8)	
2015	1500(13.8)	705(47.0)	555(78.7)	91(13.0)	60(8.5)	
2016	1000(9.2)	705(70.5)	487(69.0)	145(20.6)	73(10.4)	
2017	1800(16.6)	580(32.2)	467(80.5)	73(12.6)	40(6.9)	
2018	2100(19.4)	470(22.4)	348(74.0)	86(18.3)	36(7.6)	
Total	10,850(100)	5,223(48.1)	3804(72.8)	925(17.7)	494(9.4)	

* n=number of patient, %=percent, p=Pearson chi square

4.1.3 Prevalence of malaria in relation to different age groups in Kuergang health center

The total number of patients examined under age <5 year were 3220(29.7%) among this 1092(33.9%) were slide positive, and examined patients under the age group 5-18 were 3445(31.8%) from this 1821(52.9%) were slide positive. Out of 4185(38.6%) total blood films 2310(55.2%) were slide positive >18 years age category (see Table 3). The data showed that the highest malaria prevalence was observed in the age group of above 18 years category. The prevalence of malaria among age groups was statistically significant ($p<0.05$), which is accounted for 0.001.

Table 3 Distribution of plasmodium species by age and sex of patients in Kuergang Health center (2011-2018)

Sex	Total examined(n)%	Total slide positive(n)%	P.*falcipraum* Mono n/%/	P.vivax mono (n)/%/	Mixed (n)/%/	p- value
Male	6075(56.0)	2963(56.7)	2145(72.3)	530(17.9)	288(9.7)	0.38
Female	4775(44.0)	2260(43.3)	1659(73.4)	395(17.5)	206(9.1)	
Total	10850(100)	5223(48.1)	3804(72.8)	925(17.7)	494(9.5)	
Age						
<5	3220(29.7)	1092(33.9)	792(72.5)	187(17.1)	113(10.4)	0.001
5-18	3445(31.8)	1821(52.9)	1358(74.6)	318(17.5)	145(8.0)	
>18	4185(38.6)	2310(55.2)	1654(71.6)	420(18.2)	236(10.2)	
Total	10850(100)	5223(48.1)	3804(72.8)	925(17.7)	494(9.5)	

*** n=number of patient, %=percent, p=Pearson chi square**

4.1.4 Seasonal variation of Plasmodium species distribution in Kuergan health center

In the study area malaria was observed in almost every season of the years. Although there was a significant fluctuation, the higher number of malaria cases, was observed in June, July and August (summer) and also in September and October the prevalence of malaria was high (spring), while low *P.* species distribution rate occurred in January, February and March. The highest peak of malaria prevalence was recorded in June was 720 (18.9%), followed by October which accounted for 680 (17.9%) (Figure 3).There was a significant statistical difference in the association to season with P species distribution ($p<0.05$) in which accounted for 0.001.

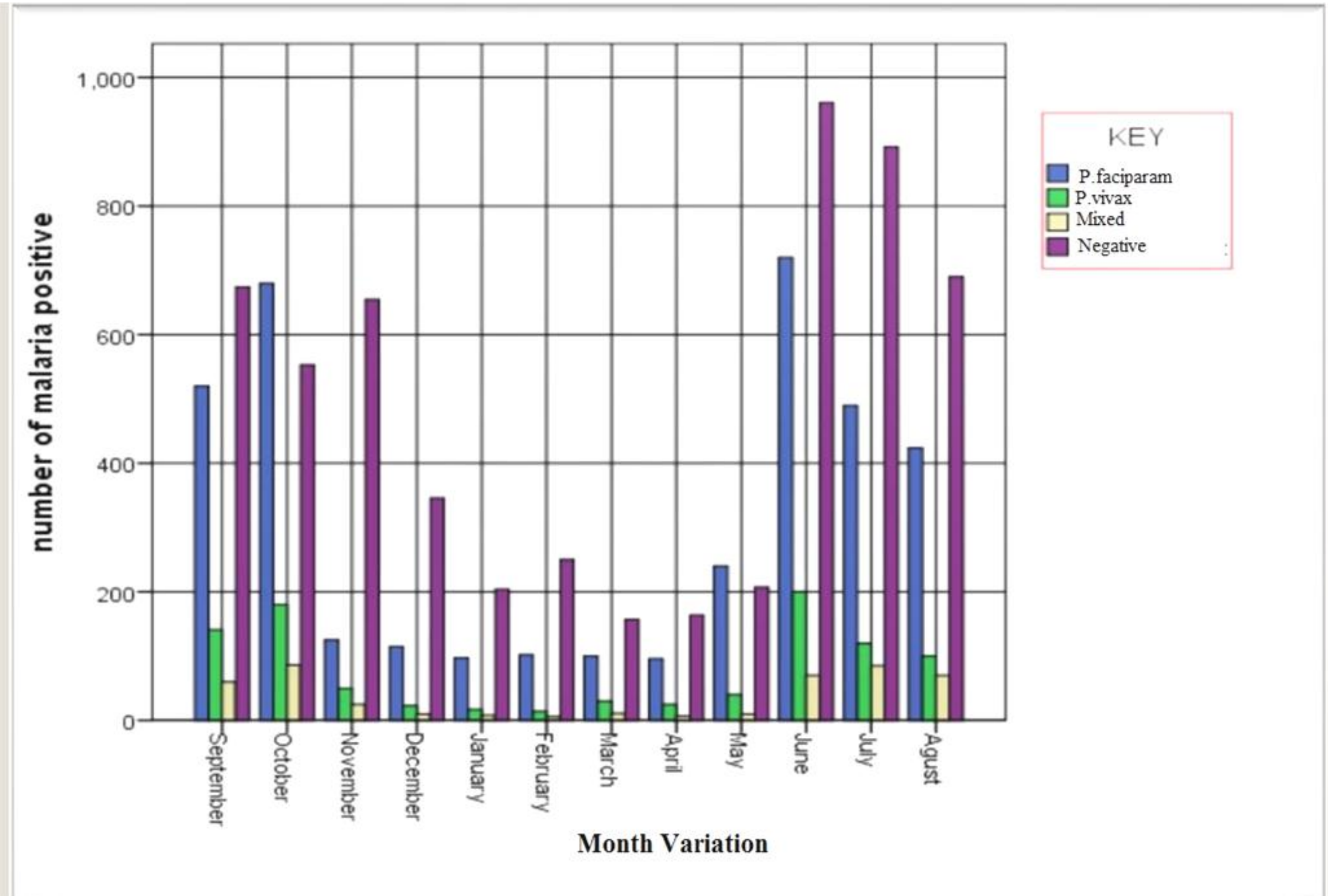

Figure 3 Monthly distribution of malaria and *Plasmodium* species variation at Kurgang town from 2011 to 2018

4.2 Current Cross-sectional Malaria Prevalence

4.2.1 Seasonal distribution of malaria in the prospective study

Among 2808 malaria diagnostic patients for malaria between September 2018 and February 2019, 924(33%) were side positive. Of this 750(81.1%) were slide positive for *P. falciparum*, 106(11.5%) for *p. vivax* and 68(7.4%) for mixed cases. There was significant difference among plasmodium species distribution, with month varation in which 81.1% of the total infection was accounted for *P.flaciprum*($p<0.05$).

In all month's malaria infection were occurred in both males and females. Among the total 1711(60.9%) male examined patients, 526(57.7%) were slide positive males and from 1097(39.1%) female examined patients 398(43.0%) were slide positive females. There was a significant difference in P. species distribution regarding to sex ($p<0.05$) (Table 4).

In relation to age category malaria was detected in all age groups. The total number of patients examined under age <5 year were 695(24.8%) among this 202(29.1%) were found to be side positive, and examined patients under the age group 5-18 were 913(32.5%), from this 315(34.5%) accounted for slide positive. The highest number of suspected patients found to be under the age category > 18 year, these 1200(42.7%) were examined, among this 407(44.1%) were slide positive for malaria. There was no significance difference in association of *P.* species with in different age category (Table 4).

The highest number of malaria cases were confirmed in September 201(58.9%) followed by October 249(39.7%) from the total 341(12.1%) and 627(22.3%) examined patients respectively. The lowest prevalence of malaria showed in November 44(9.4%) (Table 5). Month variation in relation to P. species distribution have a statistically significant difference (P<0.05).

Table 4 Prevalence of malaria infection by age and sex of patients with plasmodium species distribution from September (2018) - February (2019)

Sex	Total examined(n)%	Total slide positive (n)%	P. *falciparum* Mono(n)%	P.*vivax* mono(n)%	Mixed (n)%	p-value
Male	1711(60.9)	526(57.0)	439(83.5)	54(10.3)	33(6.3)	0.003
Female	1097(39.1)	398(43.0)	311(78.1)	52(13.1)	35(8.8)	
Total	2808(100)	924(33.0)	750(81.1)	106(11.5)	68(7.4)	
Age						0.277
<5	695(24.8)	202(29.1)	161(79.7)	24(11.9)	17(8.4)	
5-18	913(32.5)	315(34.5)	253(80.3)	37(11.7)	25(7.9)	
>18	1200(42.7)	407(34.0)	336(82.6)	45(11.1)	26(6.4)	
Total	2808(100)	924(33.0)	750(81.1)	106(11.5)	68(7.4)	

Table 5 Seasonal pattern of malaria suspected and slide-confirmed cases and species distribution in Kuergang health center.

Month	Examine(n) %	Confirmed(n)% slide positive	P.*falciparum* positive (n %)	P.*vivax* positive (n %)	Mixed (n %)	p-value
September	341(12.1)	201(58.9)	175(87.1)	17(8.5)	9(4.4)	0.001
October	627(22.3)	249(39.7)	202(81.1)	28(11.2)	19(7.6)	
November	466(16.6)	44(9.4)	33(75.0)	6(9.1)	5(11.4)	
December	414(14.7)	127(30.7)	97(76.4)	19(15.0)	11(8.6)	
January	442(15.7)	134(30.3)	104(77.6)	18(13.4)	12(9.0)	
February	518(18.4)	169(32.6)	139(82.2)	18(10.7)	12(7.1)	
Total	2808(100)	924(33.0)	750(81.1)	106(11.5)	68(7.4)	

* n=number of patient, %=percent, p=Pearson chi square

5. Discussion

The present study demonstrated that malaria prevalence fluctuated annually, with maximum and minimum number of cases recorded in 2012 and in 2018 respectively. The reduction of malaria cases in 2018 may be attributed to the combined effort of the community and other stakeholder in the control of malaria transmission. And also the season may not be confortable for the epidemiology of anopheles mosquito. The maximum number of malaria case recorded in 2012 may be due to lack of the community awareness about malaria prevention and control and the season may be suitable for the transmission of malaria. According to the present study, the overall prevalence of malaria in Kuergang health center was 48.1%. This prevalence was out of the total suspected patients. This was comparable with the study reported in Bangladish, in which the prevalence of malaria was 43.8% (Haque *et al*. 2009.)

In the percent study the number of malaria patients in 2013 and in 2014 nearly the same. This may be because of equal implementation of malaria control and prevention strategy in the two years. And also the distribution of rainfall may be the same.

Malaria prevalence showed a fluctuating trend in the study area during the past eight year from 2011-2018. The fluctuated occurrence of malaria was observed in different studies (Sena *et al*, (2014).This fluctuation occurrence of malaria may be due to lack of proper implementation of malaria control activities in the study area.

In this study from the three *P.* species, *p. falciparum*, *p.vivax* and mixed cases, plasmodium falciparum was the dominant species which accounted for 3804(72.8%) of the reported cases in eight years. This was slightly lower than a result reported in other studies in kola Diba health center (75%) (Alemu, 2012). *P. falciparum* was the dominant (72.8%) species in the study area than *P.vivax (*17.7%) this is statistically significant.

Regarding to *P.*species distribution in Ethiopia *P. falciparum* and *P.Vivax* are the two predominant malaria parasites occurring in the country accounted for 60% and 40% of malaria cases respectively (FDREMH, 2012). In my retrospective study the prevalence of P. *falciparum*, P. *Vivax* and mixed cases accounted for 72.8%, 17.7% and 9.5% respectively. Comparably in other study P. falciparum, P. vivax and mixed infections accounted for 96.6%, 2.6% and 0.8% of malaria cases, respectively (Tsegaye et al, 2014). The high prevalence of *P.falciparum* may be due to the rate of parasite infection in the study area. In addition to this the drug resistance of *P. falciparum* to coartem may be responsible for the high prevalence of *falciparum.*

In this study the prevalence of malaria was 2963(48.8%) in males and 2260(47.3%) in females, but the difference was not significant. This finding is not agree with the study conducted in different parts of Ethiopia (Haylemariam, 2015) in which males were more affected than females. In contrast lower malaria cases in males were reported from the studies in Kenya (Temu *et al,* 2012). The reason why malaria affected more males might be due to the fact males engaged in various activates outside their resident area.

Malaria prevalence with regard to age showed that *P. falciparum,* p.vivax and mixed cases were occurred in all age groups. *P. falciparum* and *P. vivax* cases were higher in age group >18 years old. Thus may be because of most of the adult men and women were perform many different activities outside and inside their home and also might be actively participate in agriculture activities and in keeping their cattle in the field. This study revealed individuals above 5 years age were more affected than children below 5 years of age. This was in agreement with studies conducted in other parts of Ethiopia and South Africa (Gemisten, 2008).

Both *P. falciparum* and *P. vivax* cases were high in the 5-18 and >18 categories. Thus two cases were less distributed within under 5 years age categories. There was statically malaria prevalence difference in different age categories. While children under less than 5 year old were less expose to malaria, this might be their parents give good protection and keeping them from anopheles mosquito bites, in which transmit malaria parasites. In addition the partially acquire immunity develop during childhood in such high malaria transmission area might have a protective role in this age group. In high malaria transmission setting partial immunity to the disease is acquired during childhood (WHO, 2017).

Among the factors that affect malaria transmission, seasonal variation has a direct role. In this study malaria transmission cases were increased from September to October and also high prevalence was shown June to August. In this study area the number of malaria cases peaked in June during summer and in September during spring. The two seasons were the major and minor transmission period may be due to the heavy rains from June to September which create suitable environment for the breading of anopheles mosquitoes. The minor transmission period was a result of small shower rains from February to March. There was statically a significant difference of transmission of malaria regarding to season. Malaria transmission is usually associated with rainy season. In my present study malaria cases were significant in winter and autumn. But the transmission rate was very low; this might be due to environmental factors such as lack of rain fall can determine the occurrence of malaria.

Regarding to the prospective study within the last six months from September 2018 to February 2019, there was high prevalence of malaria. The overall malaria prevalence in this consecutive months accounted to 33.0%. The distribution of plasmodium species were varies in each of the month so there was a significant distribution of malaria in the study Period.

In this prospective study malaria transmission peaks in both September and October. The prevalence of malaria cases in the given month has a significant difference. This might be due to the presence of rainfall in September and October.

The study had shown that females were significantly more confirmed than males. This variation was statistically significance difference in sex variation regarding to malaria occurrence. In similar studies made from Nigeria showed that the prevalence of malaria parasite was significantly higher in males than in females (Ilozumba, 2009). The high prevalence of malaria in females may be, due to involvement of females in different activities such as indoor and outdoor activities and they become tired.

In the prospective study *P. falciparum* was significantly higher than that of p.vivax and mixed cases. This may be due to the presence of *P.* parasites in the study area throughout the study season. In similar study P.*falciprum* was more frequently (69.4%) observed than *P.vivax*(30.6%) earlier report (Graves *et al*,2008) in Amhara, Oromia and southern nation nationalities and peoples (SNNPR) of Ethiopia. *P. falciparum* malaria was the major cause of the study area. This was in agreement with similar study conducted in Northwestern Ethiopia which reported that P. f*alciparum* and *P. vivax* accounted for 75% and 25% of malaria morbidity respectively (Wkgari, 2008). In relation to age group malaria was detected in all age groups. So in this prospective study there was no significant association between age and malaria occurrence. The effect of seasonality of malaria transmission on the three outcomes may be the impact of transmission intensity on the age-patterns.

6. Conclusions and Recommendations

6.1 Conclusions

1. High prevalence of malaria was observed during the study period in Kuergang town health center in both retrospective and prospective study.
2. Malaria is still among the major health problem in the study area.
3. The prevalence of malaria was recorded in Kuergang town health center ranging from the maximum 2012(72.0%) to the minimum 2018(22.4%).
4. Throughout the study period the overall prevalence of malaria in the past eight years (2011-2018) was 48.1%.
5. In the prospective study from September 2018to February 2019 high prevalence of malaria infection (33.0%) was occured.
6. This study showed that more males were infected with malaria in retrospective study whereas; in prospective study females were more affected than males.
7. There was also a different pattern of infection among the age groups in that peoples above 18 years were more vulnerable to malaria infections in retrospective study, but all age groups were affected in prospective study.
8. In relation to the type of species P. *falciparum* was the dominant parasite in both retrospective (72.8%) and prospective (81.1%) study. Both *P. vivax* and mixed cases also slightly occurred in the study area.
9. The highest peak of malaria cases was recorded in September 721(13.8%) and October 946(18.1%) and also 990(19.0 %), 695(13.3%) and 594(10.2%) were occur in June, July and August respectively.

6.2 Recommendations

- Enhancing malaria detection, scaling up malaria control and prevention activities are very essential to significantly reduce the burden of malaria.
- Health care provision must be include education to increase community awareness and practice about the way of transmission and prevention method of malaria
- The use of IRS (indoor residual spraying), ITNs and modern drugs should be practice in this area.

- The peoples living in this area should be keeping themselves from Anopheles mosquito bites in their working time and area.
- Seasonal variation should be well recognized with special focus given to annual peak seasons (months), to prevent high malaria transmissions.
- Further studies should be conducted in this area to identify the drug resistance of P. species.

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8. Appendices

Appendixe 1. raw data of malaria suspected and slide positive cases in kuergang health center from 2011-2018

Year	Examined			Malaria Positive			P.F			P.V			Mixed			Negative		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
2011	800	700	1500	394	380	774	260	248	507	92	83	175	62	36	98	400	320	720
2012	650	550	1200	510	332	842	340	266	606	105	41	141	55	25	80	150	218	368
2013	520	430	950	350	272	622	245	202	447	70	44	114	40	26	66	165	158	323
2014	440	360	800	290	235	525	225	162	387	45	50	95	18	23	41	152	126	278
2015	825	675	1500	430	275	705	350	205	555	45	46	91	35	25	60	395	399	794
2016	590	410	1000	435	270	705	305	182	487	95	50	145	35	38	73	155	139	294
2017	150	750	1800	254	326	580	195	272	467	42	31	73	17	23	40	796	424	1220
2018	1200	900	2100	300	170	470	230	118	348	50	36	86	20	16	36	900	730	1630
Total	6075	4775	10850	2963	2260	5223	2150	1655	3804	589	336	925	282	212	414	3113	2514	5627

M=male, F=female, T=total , p.f =plasmodium falciparum, p.v=plasmodium vivax

Appendixe 2. Raw data of malaria suspected and slide positive case in kuergang health center from September 2018- February 2019

Month	Examined			Malaria positive			P.F			P.V			Mixed			Negative		
	M	F	T	M	F	T	M	F	T	M	F	T	M	M	T	M	F	T
Sep	200	141	341	101	100	201	85	90	175	11	6	17	5	4	9	99	41	140
Oct	377	250	627	139	110	249	112	80	202	10	18	28	7	12	19	238	140	378
Nov	300	166	466	31	13	44	24	9	33	4	2	6	3	2	5	268	154	422
Dec	264	150	414	70	57	127	57	40	97	8	11	19	5	6	11	194	93	287
Jan	242	200	442	84	50	134	67	37	104	11	7	18	6	6	12	158	150	308
Feb	328	190	518	101	68	169	84	55	139	10	8	18	7	5	12	227	122	349
Total	1711	1097	2808	526	398	924	439	311	750	54	52	106	33	35	68	1184	700	1884

M=male, F=female, T=total , p.f =plasmodium falciparum, p.v=plasmodium vivax

Appendixes 3. Monthly data of malaria examine and malaria positive patients in kuergang health center from 2011-2018

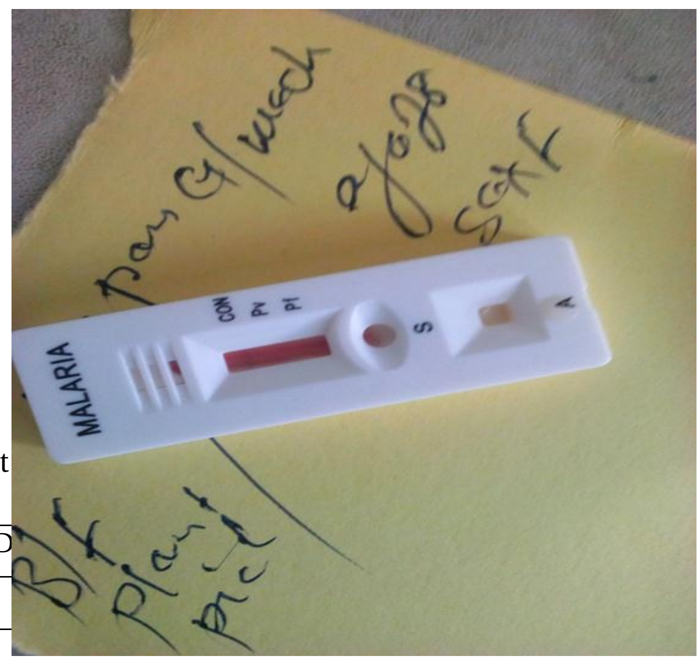
Month	**Examine**	**Malaria p.**	**p.f**	**p.v**	**Mixed**	**Negative**
Sep	1395	721	515	141	65	674
Oct	1499	946	680	170	96	553
Nov	855	326	225	50	51	529
Dec	494	148	115	23	10	346
Jan	326	122	97	17	8	204
Feb	372	122	102	14	6	250
Mar	298	141	100	30	11	157
Apr	292	128	96	20	12	164
May	497	290	240	40	10	207
Ju	1951	990	720	200	70	961
Jul	1587	695	490	120	85	892
AU	1284	594	424	100	70	690
Total	10850	5223	3804	925	494	5627

M=male, F=female, T=total , p.f =plasmodium falciparum, p.v=plasmodium vivav

Appendixes 4. Age distribution of Malaria examined and slide-confirmed cases and Plasmodium species at Kuergang town health center data collecting format.

Year	Total Examined no. (%)	Total slide positive, no.(%)	Age		
			<5 years, no.	5-18 years, no.	>18 years, no
2011					
2012					
2013					
2014					
2015					
2016					
2017					
2018					
Overall					

APPENDIXES 5 . Laboratory technician taking blood from patient and malaria RDT slide result in Kuergang health center.



Appendices 7 Laboratory results reporting format in Kuergang health center

ID	Name	Sex	Age	Malaria RDT result		Plasmodium species			
				Positive	negative	P.F	P.V	mixed	remark