Jimma University

School of Graduate Studies

Status of Malaria Prevalence in Asendabo District, Jimma Zone Southwest Ethiopia

BY: Abdurazak Jemal

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Award of the Degree of Masters of Science in General Biology

Advisor: Tsige Ketema(phD)

Oct, 2017

Jimma, Ethiopia

Approval form

Jimma University

School of Graduate Studies

Department of Biology

Title: Status of Malaria Prevalence in Asendabo District, Jimma Zone Southwest Ethiopia

By: Abdurazak Jemal

The thesis entitled '**Status of Malaria Prevalence in Asendabo District, Jimma Zone Southwest Ethiopia'** has been approved by the department of Biology for the partial fulfillment of the Degree of Master of science in General Biology.

Approved by the examining board

1. Chairperson, examination board (Jury)

Name_____ Signature _____ Date_____

2. Advisor

Name_____ Signature_____ Date_____

3. External Examiner

Name_____ Signature_____ Date_____

4. Internal Examiner

Name_____ Signature_____ Date_____

Declaration

I, the under signed, declare that this is my bona fide genuine work, has never been presented in this or other University, and that all the resources and materials used for the thesis have been dully acknowledged.

Name: Abdurazak Jemal

Signature_____

Date _____

Place: Jimma University

Date of submission_____

This thesis has been submitted for examination with my approval as candidate' advisor

Name: Tsige Ketema (PhD)

Signature_____

Date _____

Table of Contents

Acknowledgements

Firstly, I would like to express my deepest appreciation and thanks to my advisor Dr. Tsige Ketema for her critical suggestion and constructive comments starting from the topic selection to the completion of the research paper, next to God. I also thank all the study participants for their willingness to give the required information. Field staffs of my school and local health personnel supported in the data collection are dually acknowledged for their strong commitment during the data gathering and fulfilling of questionnaire. I wish to give my genuine appreciation for officials of the Asendabo health center and mainly the laboratory technician, Mr Aklilu Tadesse. I am supremely grateful to my parents for giving me time and fruitful discussions, unreserved encouragement, brilliant ideas, and their consistent follow-up. Besides, my thanks further extend to ministry of education and Jimma University for granting me a research fund and for the supporting my study.

List of abbreviations

ACIPH: Addis Continental Institute of Public Health

ACT: Artemisin Combination Therapy

DDT: Dichlorodiphenyltrichloroethane

FDRE: Federal Democratic Republic of Ethiopia

GMCS: Global Malaria Control Strategy

GDP: Growth Domestic Product

GNP: Growth National Product

HP: Health Posts

HEW: Health Extension Workers

IRS: Indoor Residual Spraying

ITN: Insecticide Treated Nets

IVM: Integrated Vector Management

KMIS: Kenya Malaria Indicator Survey

LLITN: Long-lasting insecticide treated nets

MES: Malaria Eradication Service

MVC: Malaria Vector Control

PMI: President's Malaria Initiative

RBM: Roll Back Malaria

UNICEF: United Nations Children's Fund

WHO: World Health Organization

WHA: World Health Assembly

UNGA: UN General Assembly

USEN: United State Embassy in Nigeria

List of tables

List of figures

Abstract

Recently malaria associated deaths and illness are decreasing in most malaria endemic areas of the world. The current study was undertaken to assess the status of malaria prevalence in one of malaria endemic areas of Ethiopia. Accordingly, a ten years (2007 to 2016) malaria cases report was obtained from Asendabo health center, Jimma zone, Southwest Ethiopia. In addition data on awareness of the community towards the disease transmission and prevention strategies were collected using questionnaire. Data of 65,802 febrile patients diagnosed and treated in the health center were included in the study. About 13, 595 of them were found malaria positive, showing an aggregate ten years malaria prevalence of 20.68% (95% CI, 20.37 to 20.99) was obtained. A year with highest prevalence (34.86) was 2010, while the lowest was 2015/16 (0.62%). The two *Plasmodium* species were accountable for malaria infections in the study area. About 52.13% (n=7087) of malaria cases were infected with *Plasmodium falciparum*, 44.2% were due to *P. vivax* and the remaining 7.7% were due to mixed (*P. falciparum* and *P. vivax*) infection. Dry season (from September to February)) was found malaria peak season in the study area. Number of malaria diagnosed patients in the area (46.5%, n=6336) were significantly higher (P=0.023) than other seasons. Demographic characteristics of the participants such as age, sex (being male) and educational status showed positive association with infection with malaria at least once in life time. The three major malaria prevention and control strategies such as utilization of bed net (with a coverage of 92.96%, 357/384), indoor residual spraying (mainly by government) and combination therapy (provided by health professionals at health facilities and health extension workers**)** widely undertaking in the study area. Thus, the current study is supporting evidence for the fact that the declining pattern of malaria prevalence in one of malaria endemic areas Ethiopia.

Key words: malaria, prevalence, prevention, *P. falciparum*, *P. vivax,* seasonal variatio

1. Introduction

1.1 Background

Malaria is one of the most common infectious diseases and an enormous public health problem. The disease is caused by protozoan parasites of the genus *Plasmodium*. Five species of the *plasmodium* parasite can infect humans; the most serious forms of the disease are caused by *Plasmodium falciparum*. Malaria caused by *Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae* causes milder disease in humans that is not generally fatal. A fifth species, *Plasmodium knowlesi*, causes malaria in macaques but can also infect humans (Brown, 2011). This group of human-pathogenic *Plasmodium* species is usually referred to as malaria parasites. Usually, people get malaria by being bitten by an infected female *Anopheles* mosquito. When a mosquito bites an infected person, a small amount of blood is taken, which contains microscopic malaria parasites. About one week later, when the mosquito takes its next blood meal, these parasites mix with the mosquito's saliva and are injected into the person being bitten. The parasites multiply within red blood cells, causing symptoms that include symptoms of anemia (light-headedness, shortness of breath, tachycardia, etc.), as well as other general symptoms such as fever, chills, nausea, flu-like illness, and, in severe cases, coma, and death(Novikov, 2016). Malaria transmission can be reduced by preventing mosquito bites with mosquito nets and insect repellents, or by mosquito control measures such as spraying insecticides inside houses and draining standing water where mosquitoes lay their eggs (WHO, 2010). Work has been done on malaria vaccines with limited success and more exotic controls, such as genetic manipulation of mosquitoes to make them resistant to the parasite have also been considered (Yoshida *et al*., 2007).

The number of malaria cases globally fell from an estimated 262 million in 2000 (range: 205–316 million), to 214 million in 2015 (range: 149–303 million), a decline of 18%. Most cases in 2015 are estimated to have occurred in the WHO African Region (88%), followed by the WHO South-East Asia Region (10%) and the WHO Eastern Mediterranean Region (2%).The number of malaria deaths globally fell from an estimated 839 000 in 2000 (range: 653 000–1.1 million), to 438 000 in 2015 (range: 236 000–635 000), a decline of 48%. Most deaths in 2015 were in the WHO African Region (90%), followed by the WHO South-East Asia Region (7%) and the WHO

Eastern Mediterranean Region (2%). The malaria mortality rate, which takes into account population growth, is estimated to have decreased by 60% globally between 2000 and 2015. The number of malaria deaths in children aged under 5 years is estimated to have decreased from 723 000 globally in 2000 (range: 563 000–948 000) to 306 000 in 2015 (range: 219 000–421 000). The bulk of this decrease occurred in the WHO African Region, where the estimated number of deaths fell from 694 000 in 2000 (range: 569 000–901 000) to 292 000 in 2015 (range: 212 000–384 000). As a result, malaria is no longer the leading cause of death among children in sub-Saharan Africa. The proportion of children infected with malaria parasites has halved in endemic areas of Africa since 2000. Infection prevalence among children aged 2–10 years is estimated to have declined from 33% in 2000 (uncertainty interval [UI]: 31–35%) to 16% in 2015 (UI: 14–19%), with three quarters of this change occurring after 2005(WHO, 2015).

Ethiopia's fight against malaria started more than half a century ago. Initially malaria control began as pilot control project in the 1950's and then it was launched as a national eradication campaign in the 60's followed by a control strategy in the 70's. The effort has seen alternating periods of success and failures. In 1976 the vertical organization known as the National Organization for the Control of malaria and other Vector-borne Diseases (NOCMVD) evolved from the Malaria Eradication Service (MES). The early 21st century fight in Ethiopia was guided by the Abuja (Nigeria) declaration. The current operational plan of Ethiopia, also known as "the President's Malaria Initiative (PMI) is focus on scaling up the United States Government's malaria prevention and treatment interventions in high-burden countries in sub-Saharan Africa". The PMI has a regional focus with priority to the most populous and malaria-prone regions including Oromiya (Adugna, 2011).

Many researches was done throughout the world including Ethiopia on different titles about malaria disease, its way of transmission, how to prevent it, how to control and the different years trends of malaria. In Ethiopia theses researches focus in different areas mainly where malaria disease is endemic including Asendabo too. But whatever different title's researches were done in Asendabo town and around and changes were seen in the area in relation to malaria in general, there is no research result shows the past ten years cases and the current status of malaria in Asendabo health center and in the district too. That's why this research was done on the title of "The status of malaria cases in Asendabo town and in general in the health center of Asendabo."

which are focus on the past ten years (2007 to 2016) and the current year (2017) status of malaria cases.

1.2 statement of the problem

Malaria is one of the major public health problems of underdeveloped countries. A decade ago mortality and morbidity associated with malaria was 1-3 million and 300-500million, respectively (Snow *et al*., 2005). But recently, due to strong commitment of the concerned bodies in designing and implementing effective interventional strategies, the burden drastically reduced, mainly in sub-Saharan Africa (WHO, 2015). Major prevention and control strategies are use of insecticide treated bed net,IRS, and early diagnosis and patient treatment with combination therapy.

In Ethiopia about three fourth of the country's land are malarias and more than 68% of population at risk of malaria. The burden was confined to low lands, <2000meter above sea level, but expansion to high lands or malaria free area is also observed (Ayele et al.,2012). To overcome the burden, the country set a goal of eradicating malaria in 2020. Accordingly a declining of malaria associated illness and death is achieved in some malaria endemic areas. Thus, the current study was designed to assess the current prevalence of malaria in one of malaria endemic areas.

1.3. Objectives of the study

1.3.1 General Objective

- To evaluate the status of malaria prevalence over the past ten years in one of malaria endemic area, Asendabo district, of Ethiopia.

1.3.2 Specific Objectives

- To assess the trend of malaria prevalence in Asendabo district for the past ten years,
- To compare the past ten years data of malaria cases with respect to age and sex at Asendabo health center,
- To describe the current prevalence of malaria infection in Asendabo district.
- To list the different mechanisms those apply in controlling of malaria infection in Asendabo district.

2. Literature Review

2.1 Malaria

Malaria, which is a life threatening mosquito-borne infectious disease, poses a risk to approximately 3.3 billion people or approximately half of the world's population (Brian, 2012). Most malaria cases occur in Sub-Saharan Africa (Dasgupta et al., 2012). Asia, Latin America, and to a lesser extent the Middle East and parts of Europe are also affected. In 2010, malaria was present in 106 countries and territories; there were 216 million estimated cases of malaria and nearly 0.7 million deaths – mostly among children living in Africa (QCIL, 2011). In addition to its health toll, malaria places a heavy economic burden on many endemic countries. It has been estimated that malaria can decrease Gross Domestic Product (GDP) by as much as 1.3% in countries with high disease rates (Brian, 2012).

Malaria affects the health and wealth of nations and individuals alike. In Africa today, malaria is understood to be both a disease of poverty and a cause of poverty. Malaria has significant measurable direct and indirect costs, and has been shown to be a major constraint to economic development. For developing economies this has meant that the gap in prosperity between countries with malaria and countries without malaria has become wider every single year. Annual economic growth in countries with high malaria transmission has historically been lower than in countries without malaria. Economists believe that malaria is responsible for a 'growth penalty' of up to 1.3% per year in some African countries (Shah, 2010). When compounded over the years, this penalty leads to substantial differences in GDP between countries with and without malaria and severely restrains the economic growth of the entire region. The direct costs of malaria include a combination of personal and public expenditures on both prevention and treatment of the disease. Personal expenditures include individual or family spending on ITNs, doctors' fees, antimalarial drugs, transport to health facilities, support for the patient and sometimes an accompanying family member during hospital stays. Public expenditures include spending by government on maintaining health facilities and health care infrastructure, publicly managed vector control, education and research. In some countries with a heavy malaria burden, the disease may account for as much as 40% of public health expenditure, 30% to 50% of inpatient admissions, and up to 50% of outpatient visits (RBM, 1998).

The indirect costs of malaria include lost productivity or income associated with illness or death. This might be expressed as the cost of lost workdays or absenteeism from formal employment and the value of unpaid work done in the home by both men and women. In the case of death, the indirect cost includes the discounted future lifetime earnings of those who die. Malaria has a greater impact on Africa's human resources than simple lost earnings. Although difficult to express in dollar terms, another indirect cost of malaria is the human pain and suffering caused by the disease. Malaria also hampers children's schooling and social development through both absenteeism and permanent neurological and other damage associated with severe episodes of the disease. The simple presence of malaria in a community or country also hampers individual and national prosperity due to its influence on social and economic decisions. The risk of contracting malaria in endemic areas can deter investment, both internal and external, and affect individual and household decision making in many ways that have a negative impact on economic productivity and growth (RBM, 1998).

Young children, pregnant women, people who are immune suppressed and elderly travelers are particularly at risk of severe disease. Malaria, particularly *P. falciparum*, in non-immune pregnant travelers increases the risk of maternal death, miscarriage, stillbirth and neonatal death (WHO, 2017).The development and spread of drug-resistant strains of malaria parasites is one of the greatest challenges to malaria control today. Although there is currently an increase in attention and resources aimed at malaria (Peter, 2001).

Malaria remains a leading cause of morbidity and mortality world-wide, especially in pregnant women and children, and particularly in tropical Africa, where at least 90% of the malaria deaths occur. Yet malaria is a curable disease and not an inevitable burden. Effective medicines and preventive measures are available. However, these effective and relatively inexpensive interventions reach only a small proportion of the populations in need, mainly because of insufficient financial resources. A smaller proportion of people in Africa live in areas of seasonal and less predictable transmission due to lower temperatures or rainfall in highland or desert fringe areas. Populations in these areas generally have lower levels of immunity and all age groups are vulnerable to highly seasonal transmission and epidemics. Such epidemics vary in their magnitude dependent on the situation and the causes. During the period 1997-2002, epidemics have been reported from Angola, Botswana, Burundi, Chad, Ethiopia, Kenya, Mali,

Mauritania, Mozambique, Niger, Rwanda, Senegal, Somalia, South Africa, Sudan, Swaziland, Uganda, Zambia, and Zimbabwe. Noticeable in rural areas where malaria strikes at the time of the year when there is greatest need for agricultural work. Furthermore, the disease is a common cause of school absenteeism, reaching as high as 28% in some areas. The worsening problems of resistance 10 in many parts of the world and the limited number of antimalarial medicines available have led to increasing difficulties in developing antimalarial treatment policies and the provision of prompt and effective treatment to all in need. There is a considerable amount of evidence demonstrating the relationship between increased resistance to first-line antimalarial therapy and increased morbidity and mortality. Drug resistance has also been implicated in the increasing frequency and severity of epidemics. A major constraint in reducing the burden of malaria is the lack of capacity at all levels of the health system to prevent and control the disease effectively (WHO, 2005)

2.2 Malaria parasite

Malaria parasites are micro-organisms that belong to the genus *Plasmodium*. There are more than 100 species of *Plasmodium*, which can infect many animal species such as reptile's birds, and various mammals. Four species of *Plasmodium* have long been recognized to infect humans in nature. In addition there is one species that naturally infect macaques which has recently been recognized to be a cause of zoonotic malaria in humans (John, 2012).

Plasmodium falciparum in some areas of the world is closely linked to the presence of vectors and to favorable conditions for their developmental cycle. In endemic areas like Cameroon, malaria transmission is permanently and intense. *P. falciparum*, the pathogen most widespread human malaria, is becoming increasingly resistant to antimalarial drugs deal. This requires extra effort and continuous search for new drugs, especially with new modes of action (Muregi *et al*., 2003).

P. vivax is most widely distributed in the temperate, sub tropics and some parts of the tropics. Unlike the other species, it is more common and well adapted to the temperate region than in tropics. *P. ovale* is found mostly in Africa (especially West Africa) and the island of the western pacific. It is biologically and morphologically very similar to *P. vivax*. However, differently from *P. vivax*, it can infect individuals who are negative for the Duffy blood group, which is the case

for many residents of sub-Saharan Africa. This explains the greater prevalence of *P. ovale* (rather than *P. vivax*) in most of Africa (Lucy *et al*., 2014).

P. malariae is the one of the least studied of the five species that infects humans, in part because of its low prevalence and milder clinical manifestations compared to the other species. It is widespread throughout sub-Saharan Africa, much of Southeast Asia, Indonesia, on many of the islands of the western Pacific and in areas of the Amazon Basin of South America (Scientists against Malaria, 2017).

P. knowlesi is found throughout Southern Asia as a natural pathogen of long-tailed and pigtailed macaques. It has recently been shown to be a significant cause of zoonotic malaria in that region, particularly in Malaysia. *P. knowlesi* has a 24 –hour replication cycle and so can rapidly progress from an uncomplicated to a severe infection (John, 2012).

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female Anopheles mosquitoes. Malaria is caused by Plasmodium parasites. The parasites are spread to people through the bites of infected female Anopheles mosquitoes, called "malaria vectors." There are 5 parasite species that cause malaria in humans, and 2 of these species; *P. falciparum* and *P. vivax,* pose the greatest threat. Malaria is an acute febrile illness. In a non-immune individual, symptoms usually appear 10–15 days after the infective mosquito bite. The first symptoms such as fever, headache, and chills– may be mild and difficult to recognize as malaria. If not treated within 24 hours, *P. falciparum* malaria can progress to severe illness, often leading to death (WHO, 2017).

2.3 Malaria pathology

The most severe form is caused by *P. falciparum*; variable clinical features include fever, chills, headache, muscular aching and weakness, vomiting, cough, diarrhea and abdominal pain. Other symptoms related to organ failure may supervene, such as acute renal failure, pulmonary edema, generalized convulsions, circulatory collapse, followed by coma and death. The initial symptoms, which may be mild, may not be easy to recognize as being due to malaria. Malaria is a common and life-threatening disease in many tropical and subtropical areas; these are visited by more than 125 million international travelers every year (WHO, 2017).

Only female mosquitoes feed on blood, thus males do not transmit the disease. The females of the *Anopheles* genus of mosquito prefer to feed at night. They usually start searching for a meal at dusk, and will continue throughout the night until taking a meal. Malaria parasites can also be transmitted by blood transfusions, although this is rare (Marcucci *et al*., 2004).

Malaria in humans develops via two phases: an exoerythrocytic and an erythrocytic phase. The exoerythrocytic phase involves infection of the hepatic system, or liver, whereas the erythrocytic phase involves infection of the erythrocytes, or red blood cells. When an infected mosquito pierces a person's skin to take a blood meal, sporozoites in the mosquito's saliva enter the bloodstream and migrate to the liver. Within 30 minutes of being introduced into the human host, the sporozoites infect hepatocytes, multiplying asexually and asymptomatically for a period of 6–15 days. Once in the liver, these organisms differentiate to yield thousands of merozoites, which, following rupture of their host cells, escape into the blood and infect red blood cells, thus beginning the erythrocytic stage of the life cycle (Bledsoe, 2005). The parasite escapes from the liver undetected by wrapping itself in the cell membrane of the infected host liver cell (Sturm *et* al., 2006).

Within the red blood cells, the parasites multiply further, again asexually, periodically breaking out of their hosts to invade fresh red blood cells. Several such amplification cycles occur. Thus, classical descriptions of waves of fever arise from simultaneous waves of merozoites escaping and infecting red blood cells. Some *P. vivax* and *P. ovale* sporozoites do not immediately develop into exoerythrocytic-phase merozoites, but instead produce hypnozoites that remain dormant for periods ranging from several months (6–12 months is typical) to as long as three years. After a period of dormancy, they reactivate and produce merozoites. Hypnozoites are responsible for long incubation and late relapses in these two species of malaria (Cogswell, 1992).

The parasite is relatively protected from attack by the body's immune system because for most of its human life cycle it resides within 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, thereby sequestering the parasite from passage through the general circulation and the spleen (Chen *et*

al., 2000). This "stickiness" is the main factor giving rise to hemorrhagic complications of malaria. High endothelial venules (the smallest branches of the circulatory system) can be blocked by the attachment of masses of these infected red blood cells. The blockage of these vessels causes symptoms such as in placental and cerebral malaria. In cerebral malaria the sequestrated red blood cells can breach the blood brain barrier possibly leading to coma (Adams *et al*., 2002).

In the world, about 100 countries in malaria endemic areas, half in sub-Saharan Africa, 2.4 billion at risk, 300 to 500 million cases each year, 1.0 to 2.7 million deaths in children(Sullivan and Johns Hopkins University, 2006). Malaria constitutes 25% of child mortality in Africa.90% of all malaria mortality is in under children under 5. Low birth weight, preterm delivery, cerebral malaria, and severe malarial anemia are major causes of mortality (David, 2006). According to figures provided by the World Health Organization, 36% of the global population live in areas where there is risk of malaria transmission, 7% reside in areas where malaria has never been under meaningful control, and 29% live in areas where malaria was once transmitted at low levels or not at all, but where significant transmission has been re-established (Peter, 2001).

Symptoms of malaria include fever, shivering, arthralgia (joint pain), vomiting, anemia (caused by hemolysis), hemoglobinuria, retinal damage and convulsions (Beare *et al*.,2006). The classic symptom of malaria is cyclical occurrence of sudden coldness followed by rigor and then fever and sweating lasting four to six hours, occurring every two days in *P. vivax* and *P. ovale* infections, while every three for *P. malariae. P. falciparum* can have recurrent fever every 36–48 hours or a less pronounced and almost continuous fever. For reasons that are poorly understood, but that may be related to high intracranial pressure, children with malaria frequently exhibit abnormal posturing, a sign indicating severe brain damage (Idro *et al*., 2005).

2.4 Diagnosis

Since Charles Laveran first visualized the malaria parasite in blood in 1880, the mainstay of malaria diagnosis has been the microscopic examination of blood (Sutherland and Hallett, 2009). Fever and septic shock are commonly misdiagnosed as severe malaria in Africa, leading to a failure to treat other life-threatening illnesses. In malaria-endemic areas, parasitemia does not ensure a diagnosis of severe malaria because parasitemia can be incidental to other concurrent

disease. Recent investigations suggest that malarial retinopathy is better (collective sensitivity of 95% and specificity of 90%) than any other clinical or laboratory feature in distinguishing malarial from non-malarial coma (Beare *et al*., 2006). Although blood is the sample most frequently used to make a diagnosis, both saliva and urine have been investigated as alternative, less invasive specimens (Sutherland and Hallett, 2009).

Areas that cannot afford even simple laboratory diagnostic tests often use only a history of subjective fever as the indication to treat for malaria. Using Giemsa-stained blood smears from children in Malawi, one study showed that unnecessary treatment for malaria was significantly decreased when clinical predictors (rectal temperature, nail bed pallor, and splenomegaly) were used as treatment indications, rather than the current national policy of using only a history of subjective fevers (sensitivity increased from 21% to 41%) (Redd *et al*., 2006).

2.5 Prevention and control

In terms of knowledge about transmission, symptoms, and prevention of malaria, according to the 2008 NMIS, 85.2% of women aged 15-49 years reported mosquito bites as the cause of malaria and 71.1% recognized fever as a symptom. Mosquito nets were the most commonly cited prevention method among this population at 81.3%. An ITN was the second most commonly cited prevention method, followed by "keep the house surroundings clean" and "cut the grass around the house." Taking preventive medication was the sixth most commonly cited method by approximately 10% of women. For all of the prevention methods, urban women were more knowledgeable than rural women, and were also more likely to have heard or seen a malaria message (80.7%) than rural women (70.8%). All of the women respondents, however, reported a government hospital or clinic as the source of messages about malaria (69.9%). Radio and television was the second and third most common sources of messages. Less than 5% of respondents reported peer educators or community health workers (CHWs) as the source of messages about malaria (Michelle *et al.*, 2010).

Vector control remains the most generally effective measures to prevent malaria transmission, and as such it is one of the four basic technical elements of the Global Malaria Control Strategy (GMCS). There are basically two kinds of mosquito vector control. Those directed against the adult and those against the aquatic stages. As a process for managing vector populations to reduce or interrupt transmission of disease, WHO recommends integrated vector management

(IVM). IVM is a systematic approach to planning and implementing disease vector control in an inter-sectoral context. It entails the use of a range of interventions of proven efficacy, separately or in combination for the implementation of locally cost-effective control (WHO, 2005).

There is currently no vaccine that will prevent malaria, but this is an active field of research. Vaccines for malaria are under development, with no completely effective vaccine yet available. The first promising studies demonstrating the potential for a malaria vaccine were performed in 1967 by immunizing mice with live, radiation-attenuated sporozoites, providing protection to about 60% of the mice upon subsequent injection with normal, viable sporozoites (Nussenzweig et al, 1967). Since the 1970s, there has been a considerable effort to develop similar vaccination strategies within humans. It was determined that an individual can be protected from a *P. falciparum* infection if they receive over 1000 bites from infected, irradiated mosquitoes (Hoffman et al, 2002).

Efforts to eradicate malaria by eliminating mosquitoes have been successful in some areas. Malaria was once common in the United States and southern Europe, but vector control programs, in conjunction with the monitoring and treatment of infected humans eliminated it from affluent regions. In some areas, the draining of wetland breeding grounds and better sanitation were adequate. Malaria was eliminated from the northern parts of the USA in the early twentieth century by such methods, and the use of the pesticide DDT eliminated it from the South by 1951(CDC, 2004).

Before DDT, malaria was successfully eradicated or controlled also in several tropical areas by removing or poisoning the breeding grounds of the mosquitoes or the aquatic habitats of the larva stages, for example by filling or applying oil to places with standing water. These methods have seen little application in Africa for more than half a century (Killeen et al, 2002).

The World Health Organization (WHO) currently advises the use of 12 different insecticides in IRS operations. These include DDT and a series of alternative insecticides (such as the pyrethroids permethrin and deltamethrin) to both combat malaria in areas where mosquitoes are DDT-resistant, and to slow the evolution of resistance (WHO, 2006).

The main Parasite Control methods are: Vector control & Sanitation, Vaccines? and Chemotherapy Protective (prophylaxis) Curative Prevention of transmission (David, 2006).

Vector control is the main way to prevent and reduce malaria transmission. If coverage of vector control interventions within a specific area is high enough, then a measure of protection will be conferred across the community. World health organization recommends protection for all people at risk of malaria with effective malaria vector control. Two forms of vector control – insecticide-treated mosquito nets and indoor residual spraying – are effective in a wide range of circumstances (WHO, 2017).

Insecticide-treated bed nets are nets dipped in a pyrethroid insecticide solution. This treatment creates a physical barrier, or a "halo," around the net, repelling or killing the mosquitoes. Each ITN can last up to 12 months before needing to be re-treated with insecticide. Long-lasting insecticide treated nets (LLITNs) are increasingly popular, as they last longer than traditional ITNs, repelling mosquitoes for up to four years. With LLITNs, the insecticide is woven into the fabric of the nets, causing it to self-replenish with each wash, by bringing the insecticide to the surface of the net. Mosquitoes that carry malaria are most active at night and in the early morning; bed nets are particularly vital during these times. Studies show that sleeping under a bed net can reduce child mortality from malaria by as much as 20%. The repellent in the nets can also reduce the number of mosquitoes in the surrounding area. When 80% of households use bed nets in a community, studies suggest that mortality from malaria for those living within 300 meters is significantly reduce. Ethiopia has produced tremendous results in its fight against malaria. The country's national malaria control program conducted mass distributions of LLITNs in 2005and 2006. By the end of 2007, 20 million LLITNs had been distributed (WHO, 2009).

The two main ways to reduce the spread of malaria are the use of insecticide-treated mosquito nets, and early diagnosis and prompt treatment of malaria cases. The health worker plays an enormously important role in both these approaches. His or her ability to increase understanding about malaria and then promote the use of bed nets can reduce the mortality rates of children within any community (UNICEF, 2000).

In 2010, 73 Countries, including 36 in the African Region, recommended IRS for malaria control and 13 Countries reported using DDT for IRS. Other vector control measures, for example, larvicidal and environmental management are also used when appropriate based on scientific evidence (Brian, 2012).

Prevention strategies can be divided into those aimed specifically at preventing malaria infection and those aimed at reducing the likelihood of development of drug resistance. Reduction of overall malaria infection rates or transmission rates have an indirect impact on development of drug resistance by reducing the number of infections needing to be treated (and therefore, overall drug pressure) and by reducing the likelihood that resistant parasites are successfully transmitted to new hosts. A strategy that has received much attention recently is the combination of antimalarial drugs (Peter, 2001).

WHO has decided to issue this document as a guide to current WHO recommendations for malaria control? The basis remains the Global Malaria Control Strategy, adopted in 1992 by a Ministerial Conference on Malaria and subsequently endorsed by the World Health Assembly(WHA) and the UN General Assembly(UNGA) in 1993 (WHO, 1993). This strategy is based on four basic elements: To provide early diagnosis and prompt treatment of malaria, To plan and implement selective and sustainable preventive measures, including vector control, To detect early, contain or prevent epidemics and To strengthen local capacities in basic and applied research to permit and promote the regular assessment of a country's malaria situation, in particular the ecological, social and economic determinants of disease (WHO, 2005).

As a response to the antimalarial drug resistance situation, WHO now recommends that treatment policies for falciparum malaria in all countries experiencing resistance to mono therapies, such as chloroquine, sulfadoxine/pyrimethamine and amodiaquine, should be combination therapies, preferably those containing an artemisinin derivative (ACT - artemisinin-based combination therapy). This is a change from previous recommendations. It is now considered that an effective first-line antimalarial treatment would have a greater impact on reducing mortality than merely improving second-line treatment or the management of severe malaria. Therefore, combination therapies must be available and affordable to communities for use in the first-line treatment of malaria. These conclusions are the rational culmination of the recommendations of a series of WHO informal consultations with countries and partners. There are major challenges to the deployment and use of ACT, particularly in Africa. These include the: - Cost and affordability; and - Operational obstacles to implementation, such as registration and marketing, supply, and drug quality. One of the strategies for ensuring equal access to antimalarial drugs, including ACTs, is to optimize government funding and avoid that the major

part of the health budget serves only urban centers and better-off populations. However, government financial strategies alone are unlikely to be sufficient for malaria control and external support will be needed to help finance antimalarial drug supplies. Currently, indoor residual spraying (IRS) and insecticide treated nets (ITNs) is the mainstay in malaria prevention. As vector control interventions, both are effective in preventing malaria morbidity and mortality in a range of epidemiological settings. In reducing densities and infectivity of malaria vectors, they reduce overall transmission and protect all individuals within a community (WHO, 2005).

ACTs recommended by WHO combine an artemisinin derivative such as artemether, artesunate or dihydroartemisinin with an effective antimalarial medicine (WHO, 2012).

According to the training given for HEWs of 7 kebels in Asendabo catchment area high quality laboratory based diagnosis is absolutely critical to malaria treatment and surveillance, especially in low transmission areas, like most of the Oromia region of Ethiopia. Given this the Epidemic detection project initiated a lab quality control system as one of the projects routine activities. The lab quality control process includes the storage of all malaria blood slides at each health facility and blinded rechecking of randomly selected positive and negative blood films based on the national protocol for the country. During the most recent quarter (July to September 2010) malaria cases declined or remained stable across all five primary sites (Asendabo, Kersa,Metehara,Tulubolo and Bulbula) with the exception of Tulubolo which showed increases in August. There had been significant increases in May and June especially in Bulbula; reductions have been observed thereafter (ACIPH, 2010).

Malaria was ranked as the most serious health problem. Caregivers perceived childhood malaria as a preventable and treatable disease. Most caregivers correctly associated the typical clinical manifestations with malaria attacks. Most of the caregivers would prefer to seek treatment in health-care services in the event of malaria and reported the use of recommended anti-malarias (Delenasaw *et al*., 2010).

Malaria prevention and treatment mechanisms are in place in line with the National Strategic Plan for Control of Malaria in Ethiopia, which is prepared based on the framework of the WHO Global Roll Back Malaria (RBM) Strategy. The objective of the plan is to reduce the burden of malaria, achieve the Abuja RBM target of 50% reduction

by the year 2010 and enhance the utilization of ITN to 60% by the end of 2007. So far, early diagnosis and prompt treatment, spraying of houses with insecticides, distribution of ITN and promotion of community participation in the prevention and control of malaria have been identified as priority areas for intervention(FDRE,2010).

The number of members of a house hold determines to a large extent the demand for goods and services the household purchases. The larger the household,the more strainis put on the resources available for the household's disposal. This in turn affects the general welfare of household members in terms of nutrition, as well as access to health care, bed nets, malaria medication, etc(KMIS,2010).

Indoor Residual Spraying (IRS) involves the coordinated, timely spraying of the interior walls of homes with insecticides that kill mosquitoes. Intermittent preventive treatment for pregnant women (IPTp) is an effective means of reducing the effects of malaria in both the pregnant woman and her unborn child by giving at least two doses of the drug sulfadoxine-pyrimethamine (SP). Prompt parasitological confirmation by microscopy or Rapid Diagnostic Test (RDT) is recommended for all patients with suspected malaria before treatment begins. Artemisinin-based combination therapy (ACT) has become the standard treatment of uncomplicated malaria (USEN, 2011).

Despite its initial widespread use and contribution to the success of malaria eradication and control efforts, in recent years, the use of IRS has declined. This is due in part to lack of government commitment and financing to sustain these efforts over the long term and to concerns about insecticide resistance and community acceptance. However, another important factor has been general disapproval of DDT use, due to fears of its harmful effects on the environment and on human health, fears which are unjustified when DDT is used appropriately for IRS. In the past, DDT was widely used in agriculture and domestic hygiene, leading to massive release of the compound into the environment (WHO, 2006).

A mosquito repellent has the potential to prevent malaria infection, but there has been few studies demonstrating the effectiveness of combining this strategy with the highly effective long-lasting insecticidal nets (LLINs). This study aimed to determine the effect of combining community-based mosquito repellent with LLINs in the reduction of malaria. Daily application

of mosquito repellent during the evening followed by the use of LLINs during bedtime at community level has significantly reduced malaria infection. The finding has strong implication particularly in areas where malaria vectors feed mainly in the evening before bedtime (Deressa et al, 2014).

All persons participating in the study showed good knowledge of the various methods used for MVC. All participants were familiar with IRS, as well as the use of mosquito repellents on one's self. When asked to arrange all the current methods of MVC in order of their perceived effectiveness, participants only ranked those methods with which they were familiar. Counting the number of times a method was placed in a certain position, the list in descending order of perceived effectiveness was as follows: IRS, LLINs, ITNs, environmental management, larviciding, use of mosquito repellents in the house, use of mosquito repellents on one self, biological control (Mutero et al, 2012).

From a country perspective, interruption of local mosquito borne malaria transmission, i.e. elimination of malaria, is the ultimate goal of malaria control. With rapid scale-up and sustained effrts, malaria transmission can be interrupted in low-transmission settings (WHO, 2010).

Few vector control methods can be considered as effective against malaria mosquitoes as insecticide - treated nets (ITNs) and house spraying with residual insecticides (IRS). In recent years, endemic countries using the two methods singly or in combination have reported significant declines in malaria related morbidity and mortality (Okumu and Moore, 2011).

ITNs are a form of personal protection that has been shown to reduce malaria illness, severe disease, and death due to malaria in endemic regions. In community-wide trials in several African settings, ITNs have been shown to reduce the death of children less than 5 years from all causes by about 20%. Bed nets form a protective barrier around people sleeping under them. However, bed nets treated with an insecticide are much more protective than untreated nets. The insecticides that are used for treating bed nets kill mosquitoes, as well as other insects. The insecticides also repel mosquitoes, reducing the number that enter the house and attempt to feed on people inside. In addition, if high community coverage is achieved, the numbers of mosquitoes, as well as their length of life will be reduced. When this happens, all members of the community are protected, regardless of whether or not they are using a bed net. To achieve such effects, more than half of the people in a community must use an ITN (CDC, 2015).

The mass media and interpersonal communication channels have been used to disseminate behavioral-change and information and education communications. These communications have emphasized the main benefit of LLIN retention and use – that is, malaria prevention – as well as the need to use the nets every night, irrespective of the season, the correct way to hang and use the nets, and who should be given priority for sleeping under the nets. Unfortunately, such communications have been rarer and more sporadic than intended and largely confined to the days when mass distributions were occurring. Leakage and sale of the nets were discouraged by labelling each net "NOT FOR SALE", by removing each net from its original packaging when it was distributed, and by the orientation of local leaders and authorities (Chanda et al, 2013).

The mass distribution campaigns followed a prescribed methodology and targeted 100% of the population in both rural and urban areas. They aimed to increase the level of supervision, accuracy and quality of the work conducted by community volunteers and to improve each beneficiary's knowledge of LLIN use and maintenance. For each mass distribution, a coordinator, a supervisor to cover each subcounty or *payam*, a site manager, a community registrar and one or two community "communicators" were recruited to conduct and supervise all of the logistical, financial, training and communication activities. All of these personnel were given activity-based training that was tailored to the needs of the target communities. The implementation process involved bottom-up "micro-planning", with community participation. This planning phase was followed by 5 days of household registration by community volunteers and 2 days of identifying suitable sites for the distribution of the LLINs. One net was given for every two people in each household. Supervision of the distributions was the responsibility of the supervisors, managers and implementing partners. After each mass distribution, a "hang it, use it" campaign was conducted to help householders hang the distributed nets before the distribution sites were cleaned and tidied (Ministry of Health, 2012).

2.6 Malaria burden in Ethiopia

Malaria is a leading public health problem in Ethiopia where an estimated 75% of the total area of the country with altitudes below 2000m and about 50 million people (65-68% of the population) live in areas at risk of malaria and the problem is compounded by increasing frequency and magnitude of unstable malaria epidemics. Malaria in the country is associated with altitude, rainfall, humidity and population movement, where the peak of malaria incidence

follows the main rainfall season (July - September) each year. However, many areas in the south and west of the country have a rainfall season beginning earlier in April and May or have no clearly defined rainfall season. Depending on these rainfall patterns, transmission tends to be highly heterogeneous within each year as well as between years (Teferi, 2011).

Malaria transmission is seasonal and unstable (Delenasaw *et al*., 2016).Transmission differs in intensity depending on factors such as local rainfall patterns, location of mosquito breeding sites, and presence of various mosquito species. Some areas are malaria zones throughout the year, while others have malaria "seasons" that usually coincide with the local rainy season (UNICEF, 2007).

The distribution and transmission of malaria in Ethiopia varies from place to place. For example, the distribution of malaria in Ethiopia is largely determined by altitude. Altitude affects the pattern of malaria distribution in Ethiopia through its effect on temperature. Risk of malaria is highest in the western lowlands of Oromia, Amhara, Tigray and almost the entire regions of Gambella and Benishangul Gumuz regions. The midlands of Ethiopia between 1,000 and 2,200 meters altitude experience seasonal transmission of malaria with sporadic epidemics every few years. In the eastern lowlands of Ethiopia (primarily Afar and Somali), malaria is endemic only along the rivers, as this part of the country is largely away from rivers. Transmission is limited by the lack of water collections for mosquito breeding and low humidity due to low rainfall and sparse vegetation. The central highlands of Ethiopia are free of malaria mainly due to the low temperatures, which slows the development of the vector and the parasite (Aschalew and Tadesse, 2016).

Approximately 4-5 million cases of malaria are reported annually in Ethiopia and the disease is prevalent in 75 per cent of the country, putting over 50 million people at risk. Malaria accounts for seven per cent of outpatient visits and represents the largest single cause of morbidity. The disease is ranked as the leading communicable disease in Ethiopia. The Ministry of Health summarizes, Malaria has a great socio-economic impacts in Ethiopia (Adugna, 2011).

Two main issues were raised by the HEWs during training, in Asendabo catchment area from 7 health posts (HP) or kebele, which may pose challenges to the provision of high quality

surveillance and epidemic detection, namely severe shortages of RDTs in most of the HPs and frequent stock outs of Artemisin Combination Therapy (ACIPH, 2010).

3. Materials and Methods

3.1 Description of the study area

The study was conducted in Asendabo district (Asendabo health center), located at 303km southwest of Ethiopia. The health center serves about 33,981populations. In the district malaria is one of the major seasonal health problems in the area. The two major *plasmodium* species: *P. vivax* and *P.falciparum* are responsible for malaria infection in the study area. *Anopheles arabianse* is the principal vector responsible for malaria transmission in the district.

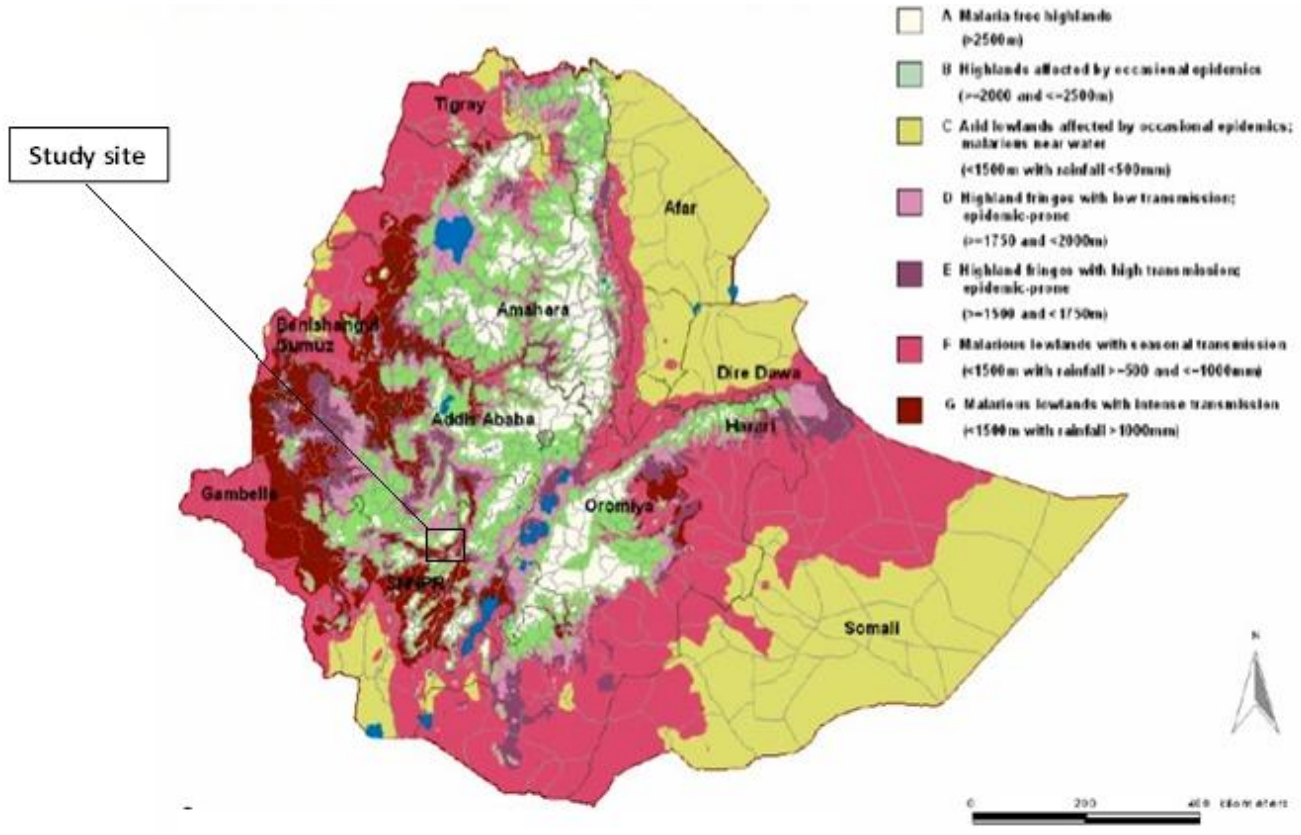


Figure 1 Map of the study site (source: Atlas map of malaria, Ethiopia)

3.2 Study Design

A retrospective study was conducted to determine the past ten years and the current year prevalence of malaria by reviewing of blood film malaria documents at Asendabo health center from January, 2007 to August, 2016 and from September, 2016 to august, 2017. A questionnaire was developed as a modification of the malaria indicator survey household to assess awareness and perception of the community, prevention and control strategies undertaking in the district.

3.3 Source of population

The study participants for questionnaires were residents of the Asendabo town, Jimma zone Southwest Ethiopia: such as health workers, teachers, other governmental employee's, students, and some residents visited the health center for the last ten years. The study population for retrospective study of malaria cases were those patients who were visiting the Asendabo health center during the past ten years and current year.

3.4 Sample size and sampling technique

The sample size was calculated using single proportion sample size formula. Accordingly a total of 384 representatives were selected to get information about interventional strategies undertaking, perception and awareness of the participants. The sample size was calculated using sample size formula indicated below;

$$n = \frac{NZ^2PQ}{D^2 (N-1) + Z^2PQ}$$

Where:

n= sample size

N= Total population of the study area

Z= Standard normal variance

P= Estimated prevalence of population 0.05)

Q= 1-P (1-0.05) = 0.05

D= Error for confidence interval (0.05)

Accordingly, a total of 384 participants were included in the study

Thus, judgment sampling method was used to select participants including health workers, kebele leaders and representative of the community. Simple random sampling method was used to select the participants from each group. Sample size for malaria case survey was all participants who visited for blood test during the past ten years and current year.

3.5 Data Collection Method

The past ten years (2007-2016) and current year(2017) records of malaria positive cases were obtained from Asendabo health center, Jimma zone. Primary data was collected using a pre-tested semi-structured interview questionnaire consists close and open ended questions.

3.6 Data Analysis

Data was checked for correctness and completeness. Thereafter, entered and analysed using SPSS (statistical packages for social sciences, SPSS) software version 20.0 (version 20.0, Armonk, NY: IBM Corp). Descriptive statistical tests were used for analysis of malaria prevalence, seasonal variation and demographic data. Different statistical tests such as independent T-test, and Pearson correlation, to show differences between variables were used. Significance level was considered at confidence interval (CI) of 95%.

3.7 Ethical consideration

The study was ethically reviewed and approved By Research and Ethical Review Board of College of Natural Sciences, Jimma University

Permission and acceptance letter were obtained from Asendabo health center prior to data collection.

4. Results

4.1 Trends of malaria prevalence

In the current study data of 65,802 febrile patients diagnosed and treated in the health center were included. About 13, 595 of them were found malaria positive, showing an aggregate malaria prevalence of 20.68% (95% CI, 20.37 to 20.99). Among the positive patients, 52.49% (n=7138) were males and 47.5% (n=6457 were females. Prevalence of malaria among biologically risked group, children <5 years was 24.36% (n=3315)(Table 1). Although the cumulative ten years prevalence of malaria showed high, the trend of malaria infection in the study area showed a declining pattern, from 27.92% in 2007 to 0.62% in 2016. The highest malaria prevalence (34.86%, n= 4963) was documented in year 2010 and followed by year 2009, with prevalence of 29.36% (n=2104). In the recent years, starting from 2013 to 2016, the prevalence drastically reduced from two digits to 0.62% (1.375 averages).

Table 1 Trend showing ten years malaria prevalence in Asendabo Health center (January, 2007-August, 2016)

Year	Total examined	Malaria positive(%)	Patients in Sex		<5 years (%)	% malaria prevalence
			Male (%)	Female (%)		
2007	6497	1814(27.9)	953(52.5)	861 (47.5)	392 (21.6%)	27.92
2008	6506	1802(27.7)	910(50.5)	892(49.5)	375(20.8)	27.73
2009	7266	2104(29.4)	1058(50.3)	1046(49.7)	617(29.3)	29.36
2010	14235	4963(34.9%)	2670(53.8)	2293(46.2)	1205(25.8)	34.86
2011	9095	1916(21.1%)	1020(53.2)	896(46.8)	452(23.6)	21.06
2012	7218	770(10.7%)	401(52.1)	369(47.9)	211(27.4)	10.67
2013	4578	137(3.0%)	76(55.5)	61(44.5)	35(25.5)	2.99
2014	3654	38(1.0%)	21(55.3)	17(44.7)	6(15.8)	1.04
2015	3879	33(0.8%)	15(45.5)	18(54.5)	13(39.4)	0.85
2016	2874	18(0.6%)	14(77.8)	4(22.2)	9(50)	0.62
Total	65,802	13595(20.7)	7138	6457	3315	20.66

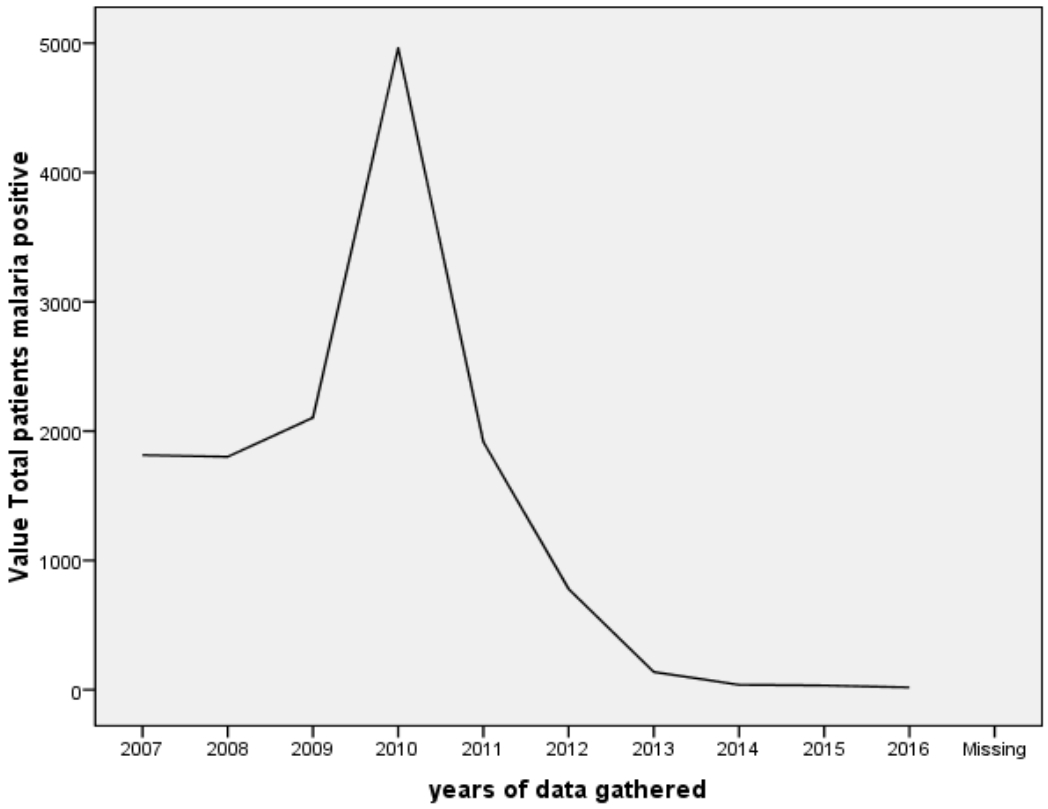
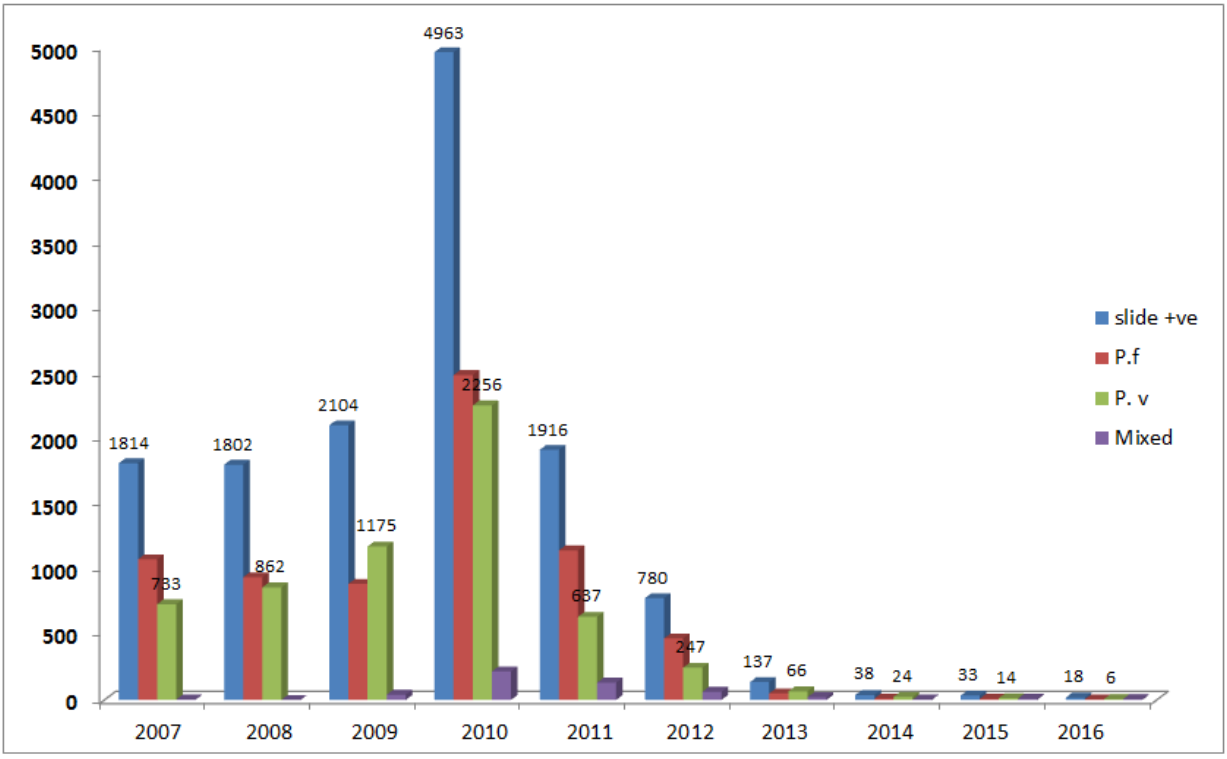


Figure 2 Trend showing ten years malaria prevalence in Asendabo Health center (January, 2007-August, 2016)

The two *Plasmodium* species were accountable for malaria infections in the study area. About 52.13% (n=7087) of malaria cases were infected with *Plasmodium falciparum*, 44.2% were due to *P. vivax* and the remaining 7.7% were due to mixed (*P. falciparum* and *P. vivax*) infection (Figure 3).



Note: Pf = Plasmodium falciparum, Pv = Plasmodium vivax, mixed = infection with both P.f and P.v

Figure 3 *Plasmodium* species accountable for malaria infection in Asendabo Health center (January, 2007-August, 2016)

4.2 Seasonal variation and prevalence of malaria

From the analysis made to assess role of seasonal variations on the prevalence of malaria, it was observed that dry seasons (from September to February in Ethiopia) was found as malaria peak season in the study area. In wet seasons (from March to august in Ethiopia) the malaria prevalence pattern seems similar. Number of malaria diagnosed patients (46.5%, n=6336) were significantly higher (P=0.023) than other seasons (Figure 4).

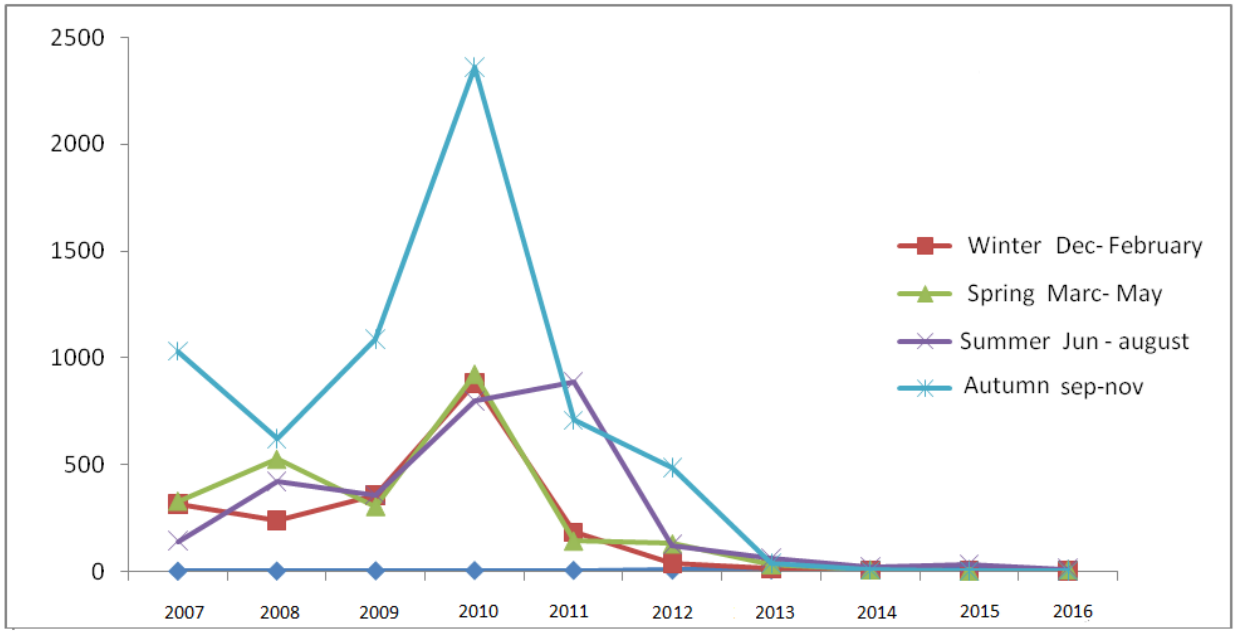


Figure 4 Malaria prevalence of malaria with reference of different seasons in Asendabo Health center, January, 2007-August, 2016(NB: Autumn and winter for dry season and spring and summer for wet season in Ethiopia).

Seasonal variation showed effects on the type of plasmodium parasite infection. Although *P. falciapum* and *P. vivax* were the two dominant parasite responsible for malaria infection in the study area, prevalence of *P. vivax* was significantly higher (P=0.042) during dry season (suptember to February in Ethiopia) than other seasons. During wet season when prevalence of the two parasite relatively decrease with similar pattern, proportion of mixed infection increased significantly (P=0.022) (Table 2).

Table 2 Prevalence of *plasmodium* species with respect to seasonal variation in Asendabo Health center, (January, 2007-August, 2016)

Year	winter season (‘Bega’			Spring seasons(‘belge)			Summe seasons(‘kiremt’)			Autumn seasons(‘tsedey’)		
	Pf	Pv	Mix	Pf	Pv	mix	Pf	Pv	mix	Pf	Pv	mix
2007	193	121	0	194	126	3	61	81	0	625	405	0
2008	69	167	0	338	185	0	343	277	0	190	231	0
2009	87	267	2	102	180	16	211	128	19	489	597	1
2010	351	494	32	536	347	33	377	353	69	1220	962	182
2011	66	107	8	67	70	14	572	237	79	441	223	44
2012	11	26	0	77	34	12	70	46	7	313	128	43
2013	2	6	1	14	11	13	22	26	13	12	23	2
2014	2	3	0	0	6	0	9	10	3	0	5	0
2015	1	0	0	0	0	0	8	14	10	0	0	0
2016	4	0	0	1	3	2	4	3	4	0	0	1
Total	786	1191	43	1329	962	93	1677	1175	204	3290	2574	273
%	5.78	8.76	0.32	9.78	7.08	0.68	12.33	8.64	1.50	24.20	18.93	2.00
P. value	0.056	0.042	0.212	0.042	0.025	0.022	0.026	0.017	0.053	0.026	0.03	0.167

Note: Pf = *Plasmodium falciparum*, Pv = *Plasmodium vivax*, mix = infection with both P.f and P.v

4.3 Current malaria prevalence

In 2016/2017, since September, 2016, a total of 2619 febrile cases were examined for malaria infection. Only 29 (1.1%) of them were malaria positive. Showing that, the declining pattern was persistent with slight increment from 0.62% (18/2874) in 2015/16 to 1.1% (29/2619) in 2016/2017, but not significantly different (P=0.056). Majority of the positive cases (n=17, 58.6%) were registered in one month (August). Among the total 29 positive patients observed, n=10 were children < 5years (Table 3).

Table 3 Current prevalence of malaria at Asendabo health center, Sept, 2016 to August, 2017

Months	Total patients tested	Confirmed malaria positive	Plasmodium species			Children <5 years
			P. f	P. v	Mix.	
September	315	1	-	1	-	0
October	178	0	-	-	-	0
November	188	0	-	-	-	0
December	184	0	-	-	-	0
January	346	1	-	1	-	1
February	176	0	-	-	-	0
March	148	1	-	1	-	1
April	138	0	-	-	-	0
May	149	2	2	-	-	0
June	203	4	3	1	-	2
July	238	3	1	2	-	2
August	356	17	12	5	-	4
Total	2619	29	18	11	-	10
%		1.10	62.07	37.93		34.48

Note: Pf = *Plasmodium falciparum*, Pv = *Plasmodium vivax*, mixed = infection with both P.f and P.v

4.4 Awareness of the community toward malaria infection

Based on the data generated from the respondents using questionnaire, some of their socio-demographic characteristics showed association with level of awareness and perception of the participants. Almost all the respondents (>98%) were well aware about malaria infection and its means of transmission, which is through bit of mosquitoes and its prevention and control approaches at house level (e.g. use of bed net). About 64.1% (246/384) of the respondents were infected with malaria at least once in their life. Demographic characteristics of the participants such as age, sex and educational status showed positive association with malaria infection at least once in life time. As age increased, the possibility of getting malaria infection was significantly (r=0.192, P=0.000) increased. Higher educational status (from elementary school

complete to post high school) was not showed associated with protection from malaria infection. Occupation and some ones religion were not associated with malaria infection (Table 4).

Table 4 Association of demographic characteristics of respondents and infection with malaria in the study area

Variable	Alternatives	Proportion (%)	Correlation coefficient (P. value)
Age	<30	209	R^2=0.192, P=0.000
	>30	132	
Sex	Female	163	R^2=0.231, P=0.001
	Male	221	
Education	Illiterate	8	R^2=0.109, P= 0.032
	Literate	376	
Occupation	Civil servant	221	R^2 =-0.017, P=0.735
	Other	163	
Religion	Muslim	220	R^2=0.056, p=0.278
	Other	164	

4.5 Interventional strategies undertaking in the study area

Almost all participants (99%, n=380) perceived that prevalence of malaria is declining in their district. The three major interventional approaches such as utilization of bed net, application of indoor residual spraying, and use of combination therapy were widely undertaking in the study site. The overall coverage of bed net was 92.96%. About 7.03% of the respondents had no bed net in their home(table 5). All family members of 55.47% were sleep under bed net. From this figure 76.56% were always use bed net during night time, while 14.84% were use bed net when population of mosquito increases during rainy season(table 5). Majority of the respondents (89%, n= 342) replied that the indoor residual spraying campaign undertake at least once per year, mainly by government (68.49). Very few (7.55%) were not aware about the program and some respondents (26.04%) didn't know the responsible body to perform the residual spraying. Most of the respondents (78.9) replied that they get combination therapy (Coartem, Artemethrin lumefantrin) and chloroquine from health facilities or by health extension workers. Besides

giving drug for the patients, the health extension workers play a big role in enhancing awareness of the community towards malaria infection, transmission, and prevention methods (Table 5).

Table 5 Interventional approaches under taking to prevent and control malaria in Asendabo district

Interventional strategies	Alternatives	Alternatives	Proportion (%)
Bed net utilization	No of bed nets/household	1-3	296 (77.08)
		>3	61 (15.88)
		None	27 (7.03)
	Family members that sleep under bed net	All	213 (55.47)
		Some	144 (37.5)
	Frequency of use	Always	294 (76.56)
		When population of mosquito rise	57 (14.84)
		Some time	15 (3.9)
Indoor-residual spraying	Frequency of spraying	Once/year	342 (89)
		Twice/year	13 (3.38)
		Do not know	29 (7.55)
	Responsible body	Government	263 (68.49)
		NGOs	21 (5.4)
		Do not know	100 (26.04)
Combination therapy	Health facilities	By professional health workers	303 (78.9)
	Role of health extension workers	Enhancing awareness	225 (58.59)
		provide treatment in remote areas	71 (18.49)
		Both	54 (14.06)
		Unknown	4 (1.04)

5. Discussion

In the current study the aggregate ten years malaria prevalence observed was 20.68%. The distribution of this figure was varies from 34.68% prevalence in 2010 to 0.62% in 2016. Like the scenario in other developing countries, some years back malaria was a major public health concern in the study site. But, recently due to strong commitment of the concerned bodies, nationally the prevalence of malaria is drastically reducing in most parts of the country (Deribew *et al*., 2017). Thus, the observed significant reduction of malaria prevalence in the study site is an evidence for fruitful interventional mechanism undertaken in the study area.

Similarly, the ten years trend of malaria prevalence in the study area showed a drastic decreasing pattern. Although the declining pattern throughout the ten year was consistent, the fact that slight prevalence increment observed in the current year (2016/17) could assist a relapse of malaria infection in the study area. This is because, despite impressive successful achievement of malaria prevalence reduction through vector control, complete elimination of malaria is impossible (Killeen *et al*., 2013; Smith *et al*., 2013). This is due to the persistence of residual transmission of the disease (Killeen, 2014). Thus, close monitoring and surveillance of interventional tactics and the infection pattern is very important.

One of the determinants for malaria transmission is seasonal variation. Temperature and humidity are factors govern *plasmodium* parasite growth in the vector body and the vector development in environment. Thus, optimum climate condition is important for the disease spread and perseverance. Dry season (from September to February in Ethiopia) was found a peak malaria transmission season. This finding was in agreement with report of Jamil and Khan (2012), where prevalence of *P. falciparum* malaria reached its highest frequency in the autumn season in Pakistani. In the country autumn is a time after heavy rain (Wiwanitkit and Suyaphun, 2005). This observation is supported by similar reports from the same country, Butajira-Ethiopia, where seasonality of malaria manifested and predominantly after the main rainy season (Woyessa *et al.*, 2012).

Ethiopia has set a goal of eliminating malaria in 2020, at least in low malaria transmission set ups (FMoH, 2014). So that, long-lasting insecticidal treated bed nets (LLINs) and indoor residual

spraying (IRS) interventional approaches, are the major tools considered to achieve this goal (Killeen, 2014). Thus, LLIN distribution and IRS services are delivered free of any charge in Ethiopia, the cost mainly covered by donations through the MoH or direct government budgeting (Hailu *et al*., 2016). There was also a national plan of achieving 100% LLINs coverage in 2007, before a decade (MIS, 2011). However, the recent report from the national survey in 2015 showed that, the overall households owned LLIN was 69% (FMoH, 2015). Compared to the national coverage, the overall distribution of LLIN observed in the study area was much better (92.96%), and also comparable to the reports from northwestern part of Ethiopia, which was 95.5% (Ayalew *et al*., 2016).

The status of indoor residual spraying coverage every year observed in the study was 96%. This figure is higher than IRS coverage reported from rural areas of South Central Ethiopia (72.5%) (Hailu *et al*., 2016). Identification of behavioral determinants in relation to LLIN use, IRS acceptability and health care seeking is a critical step in the development of effective, targeted interventions aiming to further reduce malaria transmission and elimination (Ingabire *et al*., 2015). However, *An. Arabiensis*, principal vector of malaria collected around the study site, already developed resistant trait to insecticides for LLINs such as DDT, deltamethrin, lambda-cyhalothrin and malathion (Asale *et al*., 2014).

One of the best experiences supported the success of malaria prevention and control process in the country; particularly in the study area was presence of health extension workers (HEWs). Their major role is enhancing awareness of the community towards malaria infection, its transmission, and different prevention methods, mainly in malaria endemic areas (Medhanyie *et al*., 2012). These workers spend 75% of their time visiting families in their homes and performing outreach activities in the community (Sebhatu, 2008) and distributed artemisinin-based combination therapy (ACT) to the community. Presence of HEWs is very important for the early observation and reporting of malaria cases for further diagnosis at nearby health facilities and treatment with appropriate antimalarial drugs (Birhanu *et al*., 2016). This could be one of the factor facilitated reduction of malaria burden in the study area.

In general the use of bed net, IRS, combination therapy and contribution of different stakeholders including HEW have a great role in declining of malaria infection in the study area (Gemechu, 2014).

6. Conclusion

The current study provides supportive evidence for the reduction of malaria prevalence in Jimma zone, Asendabo district. This could serve as an evidence for the dramatic rise in commitment of all the stakeholders to control malaria in the country.

7. Recommendation

The observed declining of malaria prevalence observed in the current study is a promising result which could be cascaded to other malaria endemic areas. Thus, concerned bodies should share the best experience on malaria interventional strategies undertaken in the study site.

8. References

ACIPH, (2010).Malaria epidemic detection initiative in Oromia, Ethiopia. Public health and Tropical medicine, 2010; 1:1-4.

Adams S, Brown H, Turner G (2002). Breaking down the blood-brain barrier: signaling a path to cerebral malaria. *Trends Parasitol* **18** (8): 360–6.

Adugna A. (2011). Malaria in Ethiopia. *www.EthioDemographyAndHealth*. *Org*.Lesson, 14:1-7.

Asale A, Getachew Y, Hailesilassie W, Speybroeck N, Duchateau L, Yewhalaw D.(2014). Evaluation of the efficacy of DDT indoor residual spraying and long-lasting insecticidal nets against insecticide resistant populations of Anopheles arabiensis Patton (Diptera: Culicidae) from Ethiopia using experimental huts. Parasites & Vectors, **7**:131,

Aschalew, A. and Tadesse, D (2016).Current Status of Malaria in Ethiopia: Evaluation of the Burden, Factors for Transmission and Prevention Methods. *Acta Parasitological Globalis,* **7**:1

Ayalew S, Mamo H, Animut A, Erko B (2016) Assessment of Current Malaria Status in Light of the Ongoing Control Interventions, Socio-Demographic and Environmental Variables in Jiga Area, Northwest Ethiopia. PLoS ONE 11(1): e0146214.

Ayele D., Zewotir T. and Mwambi H. (2012). Prevalence and risk factors of malaria in Ethiopia, Malaria Journal201211:6-8.

Beare NA, Taylor TE, Harding SP, Lewallen S, Molyneux ME (2006). Malarial retinopathy: a newly established diagnostic sign in severe malaria. *Am. J. Trop. Med. Hyg*.**75** (5):790–7.

Birhanu Z, Abebe L, Sudhakar M, Dissanayake G, Yihdego YY-e, Alemayehu G, et al. (2016) Malaria Related Perceptions, Care Seeking after Onset of Fever and Anti-Malarial Drug Use in Malaria Endemic Settings of Southwest Ethiopia. PLoS ONE 11(8): e0160234.

Bledsoe, G. H. (December 2005). Malaria primer for clinicians in the United States *Southern Medical Journal* 98(12): pp. 1197–204.

Brian B., Susmita D., Abdelaziz L. and Subhendu R.(2012).Health Costs and Benefits of DDT Use in Malaria Control and Prevention.The World Bank Development Research Group Environment and Energy Team, 2012; pp:1-2.

Brown G. (2011).Control and Eradication of Malaria: Past, Present and Future, Health 2011, www.Future leaders.com.au, pp: 65-68.

CDC (2004). Eradication of Malaria in the United States (1947-1951) 2004; http://www.cdc.gov/malaria/history/eradication_us.htm

CDC (2015). Health care providers needing assistance with diagnosis or management of suspected cases of malaria. Global Health – Division of Parasitic Diseases and Malaria; PP: 5-9.

Chanda E, Remijo CD.,Pasquale H.,Baba SP. and Lako RL.(2013). Scale-up of a programme for malaria vector control using long-lasting insecticide-treated nets: lessons from South Sudan. *Bulletin of the World Health Organization* 2014; 92:290-296. doi: http://dx.doi.org/10.2471/BLT.13.126862

Chen Q, Schlichtherle M, Wahlgren M (July 2000). Molecular aspects of severe malaria. *Clin. Microbiol. Rev.* **13** (3): 439–50.

Cogswell FB (January 1992). The hypnozoite and relapse in primate malaria. *Clin. Microbiol. Rev.* **5** (1): 26–35.

Dasgupta S., Blankespoor B., Lagnaoui A. and Roy S. (2012). Heath costs and benefits of DDT use in malaria control and prevention. Environment and Energy Research wps6203:1-2.

David, S. (2006). Malariology overview. *Malaria*, 2006; pp: 22-24.

Delenasaw Y. , Wondwossen K. , Kifle W. , Kora T. , Morankar S. ,Daniel K. , Luc D. , Wim V. , Niko S.(2010).The influence of the Gilgel-Gibe hydroelectric dam in Ethiopia on caregivers' knowledge, perceptions and health-seeking behavior towards childhood malaria. *Malaria Journal;* **9:** 1-2.

Deressa W., Yihdego Y., Kebede Z., Batisso E., Tekalegne A., Dagne G (2014). Effect of combining mosquito repellent and insecticide treated net on malaria prevalence in Southern Ethiopia, BioMed Central Ltd. 2014; PP:2-4.

Deribew A, Dejene T, Kebede B, Assefa G, Adama Y, Misganaw A, Gebre T, Hailu A, Biadgilign S, Amberbir A, Desalegn B, Alemu A, Shafi O, Abera SF, Negussu N, Mengistu B, Amare AT, Mulugeta A, Mengistu B, Tadesse Z, Sileshi M, Cromwell

E, Glenn SD, Deribe K, Stanaway JD (2017). Incidence, prevalence and mortality rates of malaria in Ethiopia from 1990 to 2015: analysis of the global burden of diseases 2015. Malar J 16(1):271.

FDRE (2010). Report of the Federal Democratic Republic of Ethiopia on the implementation of the AU Solemn declaration on genders equality in Africa, pp: 5-7.

FMoH (2015). Ethiopian National malaria indicator survey. Technical summery pp 15

FMoH. (2014). National malaria program monitoring and evaluation plan 2014–2020. Federal Democratic Republic of Ethiopia Ministry of Health. Addis Ababa; 2014.

Focosi D. (2002).HOMO SAPIENS DISEASES – PROTOZOA, Nature Insight Malaria in Nature, 2002; 415:106-121.

Gemechu T.(2014). Ten Years Trend Analysis of Malaria Prevalence in Relation to Climatic Variables in Sibu Sire District, East Wollega Zone, Oromia regional State, Western Ethiopia: A retrospective Study. Malaria journal, 2014. pp: 34-37.

Hailu A, Lindtjørn B, Deressa W, Gari T, Loha E and Robberstad B (2016). Equity in long-lasting insecticidal nets and indoor residual spraying for malaria prevention in a rural South Central Ethiopia. Malaria J, 15:366

Hoffman SL, Goh LM, Luke TC. (2002). Protection of humans against malaria by immunization with radiation-attenuated Plasmodium falciparum sporozoites. *J. Infect. Dis.* **185** (8): 1155–64.

Idro, R, Otieno G, White S, Kahindi A, Fegan G, Ogutu B, Mithwani S, Maitland K, Neville BG, Newton CR(2005). Decorticate, decerebrate and opisthotonic posturing and seizures in Kenyan children with cerebral malaria. *Malaria Journal* **4** (57): 57.

Ingabire CM., Rulisa A., Kempen LV., Muvunyi C., Koenraa CJM.,Vugt MV., Mutesa L., Borne BVN and Alaii J(2015). Factors impeding the acceptability and use of malaria preventive measures: implications for malaria elimination in eastern Rwanda. Malaria Journal2015; 14:136 .

Jamil S and Khan MN. Seasonal variations of vivax and falciparum malaria: an observation at a tertiary care hospital. J Ayub Med Coll Abbottabad. 2012 Jan-Mar; 24(1):93-5.

John C. Igweh (2012). Biology of Malaria Parasites, ISBN: 20-25.

KMIS (2010). Division of Malaria Control, Ministry of Public Health and Sanitation. Kenya National Bureau of Statistics, head.domc@domckenya.or.ke, PP: 11-20.

Killeen G, Fillinger U, Kiche I, Gouagna L, Knols B (2002). Eradication of Anopheles gambiae from Brazil: lessons for malaria control in Africa? *Lancet Infect Dis* **2** (10): e192.

Killeen GF (2014). Characterizing, controlling and eliminating residual malaria transmission. *Malaria Journal* 2014; 13:330 https://doi.org/10.1186/1475-2875-13-330.

Killeen GF, Seyoum A, Sikaala CH, Zomboko AS, Gimnig JE, Govella NJ, White MT(2013). Eliminating malaria vectors. Parasite Vectors. 2013, 6: 172-10.1186/1756-3305-6-172.

Legesse M. and Deressa W. (2009). Community awareness about malaria, its treatment and mosquito vector in rural highlands of central Ethiopia, *Ethiop.J.Health Dev*. 2009; 23(1): 40-45.

Lucy G., Daniel M., Kenneth A., Mjomba A. and Njogu S. (2014) Determination of *Plasmodium* Parasite Life Stages and Species in Images of Thin Blood Smears Using Artificial Neural Network. *Open Journal of Clinical Diagnostics.* 4,78-80.

Manual for the Laboratory Diagnosis of Malaria (2012). Ethiopian Health and Nutrition Research Institute (EHNRI)/Ethiopian Federal Ministry of Health. Addis Ababa: Ministry of Health [Ethiopia]; 2012.

Marcucci C, Madjdpour C, Spahn D (2004). Allogeneic blood transfusions: benefit, risks and clinical indications in countries with a low or high human development index. *Br Med Bull* **70**: 15–28.

Medhanyie A, Spigt M, Kifle Y, Schaay N, Sanders D, Blanco R, GeertJan D and Berhane Y (2012). The role of health extension workers in improving utilization of maternal health services in rural areas in Ethiopia: a cross sectional study. BMC Health Services Research, 12:352

Michelle W., Elaine R., William B. and Barbara R. (2010). MALARIA IN PREGNANCY CASE STUDY: Zambia's Successes and Remaining Challenges for Malaria in Pregnancy Programming, 7:27-29.

Ministry of Health (2012). *Methodology for LLIN mass distribution*. Juba: Ministry of Health; 2012.

MIS (2011). Ethiopian National Malaria Survey Indicator 2011 [http://www.unicef.org/ethiopia/ET_MIS_2011_Report.pdf]

Muregi FW, Chlabra SC, Njagi ENM, Lang'at-Thoruur CC, Njue WM,Orago ASS, Omar SA, Ndiege IO (2003). In vitro antiplasmodial activity of some plants used in Kissii, Kenya against malaria and their chloroquine potential effect. J. Ethnopharmacol., 84: 104-106.

Mutero C., Schlodder D., Kabatereine N., Kramer R(2012). Integrated vector management for malaria control in Uganda: knowledge, perceptions and policy development, *Malaria Journal;* 15:7-9.

Novikov Y., (2016). Malaria superbugs threaten global malaria control. *Malaria Journal; 4-5.*

Nussenzweig R, Vanderberg J, Most H, Orton C (1967). Protective immunity produced by the injection of x-irradiated sporozoites of plasmodium berghei. *Nature* **216** (5111): 160–2.

Okumu FO and Moore SJ, (2011). Combining indoor residual spraying and insecticide-treated nets for malaria control in Africa: a review of possible outcomes and an outline of suggestions for the future. *Okumu and Moore Malaria Journal* 2011, 10:208

Peter, B.Bloland (2001). Drug resistance in malaria. WHO, 2001; 4:2-20.

QCIL, 2011, Malaria Fact Sheet.

http://www.qcil.co.ug/index.php?option=com k2&view=item&layout=item&id=23&itemid=73

RBM. (1998).Economic costs of Malaria, WHO;pp.: 1-2.

Redd S, Kazembe P, Luby S, Nwanyanwu O, Hightower A, Ziba C, Wirima J, Chitsulo L, Franco C, Olivar M (2006). Clinical algorithm for treatment of Plasmodium falciparum malaria in children. *Lancet* **347** (8996): 80.

Scientists against Malaria, 2017 (http://www.scientistsagainstmalaria.net) (Accessed 09- Aug. 2017).

Sebhatu A. (2008). The implementation of Ethiopia's Health Extension Program, *Ethiopia Good Practice: HEP*; PP: 2-5.

Shah A. (2010). Diseases—Ignored Global Killers, *Global Issues,* accessed in November 7, 2017 http://www.globalissues.org/article/218/diseases-ignored-global-killers

Smith DL, Cohen JM, Chiyaka C, Johnston G, Gething PW, Gosling R, Buckee CO, Laxminarayan R, Hay SI, Tatem AJ: A sticky situation: the unexpected stability of

malaria elimination. Philos Trans R Soc Lond B Biol Sci. 2013, 368: 20120145-10.1098/rstb.2012.0145.

Snow RW, Guerra CA, Noor AM, Myint HY, Hay SI (2005). The global distribution of clinical episodes of Plasmodium falciparum malaria. *Nature* **434** (7030): 214–7.

Sturm A, Amino R, van de Sand C, Regen T, Retzlaff S, Rennenberg A, Krueger A, Pollok JM, Menard R, Heussler VT (2006). Manipulation of host hepatocytes by the malaria parasite for delivery into liver sinusoids. *Science* **313**: 1287–1490.

Sullivan D. and Johns Hopkins University (2006). History, Lifecycle, Epidemiology, Pathology, and Control, *Malariology Overview,* 3:22-25.

Sutherland CJ, Hallett R (2009). Detecting malaria parasites outside the blood. *J Infect Dis* **199** (11): 1561–1563.

Teferi, E. (2011). Efficacy and tolerability of Antimalarial and Molecular resistance markers of Falciparum Malaria in Jimma, Ethiopia. *Malaria Journal*; **7:6**-7.

UNICEF, (2007). An Introduction to Malaria. A curriculum resource for secondary teachers, 2007; PP: 11-13.

UNICEF,(2000).Global malaria. The prescriber, 2000; 18:1-14.

USEN, (2011). Nigeria malaria case fact sheet, pp: 102.

WHO (1993). Implementation of the Global Malaria Control Strategy. Report of a Study Group on the Implementation of the Global Plan of Action 1993-2000. WHO Technical Report Series No. 839.

WHO (2005). Malaria controltoday, 2005(http://WWW.who.int/malaria/docs/malaria control today 2005.pdf).(Accessed 15-Feb. 2017).

WHO (2006). Indoor Residual Spraying: Use of Indoor Residual Spraying for Scaling Up Global Malaria Control and Elimination

WHO. (2009). Malaria rapid diagnostic test performance. Geneva, Switzerland: world health organization, 20:

WHO (2010). World malaria report, WHO global malaria programme, 20:5-9.

WHO (2011). World Malaria Report, 2011 http://www.who.int/malaria/world_malaria_report_2011/9789241564403_eng.pdf

WHO. (2012). Effectiveness of Non-Pharmaceutical Forms of *Artemisia annua* L. against malaria

WHO. (2015). World malaria report. Geneva Switzerland: World Health Organization.

WHO. (2017), Global malaria programme Geneva Switzerland: World Health Organization;

Wiwanitkit V. and Suyaphun A. (2005). Seasonal Variation in the Prevalence of Plasmodium vivax Malarial Infection: An Observation in Northern Thailand. Medscape General Medicine. 7(2):7.

Woyessa A., Deressa W., Ali A., Lindtjorn B.(2012). Prevalence of malaria infection in Butajira area, south-central Ethiopia. *Malaria J,* 11:84.

Yoshida S, Shimada Y, Kondoh D, (2007). Hemolytic C-type lectin CEL-III from sea cucumber expressed in transgenic mosquitoes impairs malaria parasite development. *PLoS Pathog.* **3** (12): e192.

9. Annexes

Annex 1

JimmaUniversity

College Of Natural Science

Biology Department

Questionnaire on the Status of Malaria infection in Asendabo district, Jimma zone Southwest Ethiopia

Please fill the space provided with the appropriate information.

Put a sign of 'x' in the blank space.

Age _____

1. Sex: male_____ female_____

2. Address: rural_____ urban_____

3. Religion: Muslim_____ protestant _____ Orthodox _____

others(specify)_____

4. Ethnicity: Oromo_____Amhara_____ Tigre_____

Gurage _____ yem_____ others (specify)_____

5. Occupation: civil servant_____ house wife_____ student_____

Merchant _____ other (specify)_____

6. Educational level: unformed (adult education)_____ Illiterate_____

Literate_____ Informal education_____1-4_____ 5-8_____

9-12_____10+ higher education12+higher education_____

7. Do you know a disease Malaria? Yes_____ No_____

8. Is there disease malaria in your local area before? Yes_____ No_____

9. Are you infected by Malaria disease in your past life? Yes_____ No_____

10. If your answer for question #9 is 'yes', What type of treatment have you taken for the illness?
a. I use traditional medicine. b. I go to health center c. Other_ _____

11. Is any of your family members infected by Malaria in the past 10 years? Yes____ No___

If your answer for question #11 is 'yes'

12. How many of your parent(s)are infected? One_____ two_____ three_____

> three_____

13. How much time the disease repeatedly occurs in any of your parent's member?

Only once_____ two times_____ three times_____ > three times_____

14. How many of your family members get treatment?

Only one_____ two_____ three_____ > three_____

15. How many of your family members died because of malaria?

None_____ one_____ two_____ > two_____

16. What is your opinion about the prevalence of malaria in your locality before the past ten years?

a. Decline from year to year

b.The same from year to year

c.Increase from year to year

Other specify_____

17. If your answer for question #16 is 'Decline from year to year',

What are the interventional mechanism(s) undertaken in the past 10 years? (>one answer is possible):

a. Contribution of other stakeholders

b. Increased awareness of the population and improved prevention methods

c .Using of indoor-residual spraying

d. Using of bed net

e. Using of combination therapy (Coartem)

Mention, if possible _____

18. How does malaria transmit from infected to non-infected?

a. By using common utensils

b. Sleeping together

c. Through bit of mosquito

d. By drinking contaminated water

e. Through blood contact

f. Through sharing of cloths

Using of bed net:

20. How many bed nets do you have? _____

21. Are all your family members use bed net? Yes_____ No_____

22. How frequent they use bed net?

a. Always during night time

b. Only when population of mosquitoes increases

c. Other specify

Using of indoor-residual spraying:

23. How many times a year spraying is undertaken _____

24. Who is responsible for the spraying?

a. government b. NGOs c. Others

25. Does the chemical sprayed has health effects: yes_____ No_____

26. What is/are the role(s) of Health extension workers in relation to malaria disease in your local area? (more than one answer is possible)

a. They help by enhancing awareness of the community before occurrence of the disease

b. They give treatment for the malaria patient

c. They have no role

d. Other specify

27. Have you seen or heard recently about any one infected with malaria disease?

Yes_____ No_____

If your answer for the question #27 is 'yes',

28. How can the disease been reemerged? (Short answer)

_____
_____

If your answer for the question #27 is 'No',

Why not you can see malaria infected patient or not heard about (short answer)

_____
_____
_____

29. What is your suggestion in sustainable control of malaria infection(disease) in your local area, district of Asendabo, (short an

_____
_____
_____

THANK YOU!

Annex 2

General characteristics to be identified from the data of patients of the study area of the Past ten years and current year

Data characteristics	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Characteristics											
Total patient(Blood tested)											
Total patient(Blood tested) in Age											
Total patient(Blood tested) in sex											
Total Confirmed malaria (+ve case)											
0-4 years Participants											
5-14 years											
15-44 years											
Infection due to P. falciparum											
Infection due to P. vivax											
Infection due to mixed parasite											
0-4 years with +ve case											
Total Confirmed malaria (+ve case) monthly(seasonally)											

Annex 3

Table for Malaria tested and malaria positive in the past 10 years in Asendabo health centre

No	Year	**Total patient(Blood tested)**			**Total Confirmed malaria** **(+ve case)** and %			Remark
		Male	**Female**	**Total**	**Male**	**Female**	**Total(%)**	
1	2007							
2	2008							
3	2009							
4	2010							
5	2011							
6	2012							
7	2013							
8	2014							
9	2015							
10	2016							
	Total							

Annex 4

Table for Malaria positive in age case and plasmodium species type in the past 10 years in Asendabo health centre

No	Year	**Total patient(Blood tested)**	**Total Confirmed malaria (+ve case)**	Malaria Positive in age		plasmodium species type		
				Under -5	≥ 5	P.falciparum	P.vivax	Mixed
1	2007							
2	2008							
3	2009							
4	2010							
5	2011							
6	2012							
7	2013							
8	2014							
9	2015							
10	2016							
	Total							

Annex 5

Table for Malaria tested patients in different seasons in the past 10 years in Asendabo health centre

No	Year	Seasons of the year					Remark
		Spring	Summer	Autumn	Winter	Total	
1	2007						
2	2008						
3	2009						
4	2010						
5	2011						
6	2012						
7	2013						
8	2014						
9	2015						
10	2016						
	Total						

Annex 6

Table for Malaria positive patients in different seasons in the past 10 years in Asendabo health centre

No	Year	Seasons of the year					Remark
		Spring	Summer	Autumn	Winter	Total	
1	2007						
2	2008						
3	2009						
4	2010						
5	2011						
6	2012						
7	2013						
8	2014						
9	2015						
10	2016						
	Total						

By Abdurazak Jemal,

Biology Department.

ID. Number: SMSC 00931/06

October, 2017

Jimma-Ethiopia