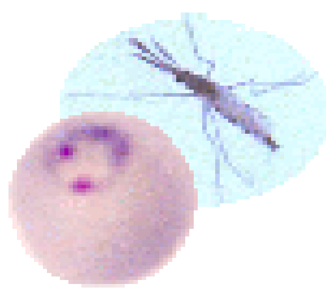
ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCINCES

DEPARTMENT OF ZOOLOGICAL SCIENCES

STUDIES ON THE PREVALENCE OF MALARIA AND UTILIZATION OF MOSQUITO NETS IN DUBTI WOREDA, NORTH EAST ETHIOPIA



By

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Finally, I thank God for directing, assisting and strengthening me throughout my study.

Declaration

I declare that this thesis entitled "Studies on the prevalence of malaria and utilization of mosquito nets in Dubti Woreda, North East Ethiopia" is my original work, has not been presented for a degree in any other University and source of materials used for the study have been duly acknowledged.

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Acronyms and Abbreviations

ACT	Artemisinin - Based Combination Therapy
AMREF	African Medical and Research Foundation
CDC	Center for Disease Control and Prevention
CI	Confidence Interval
CSA	Central Statistics Agency
DDT	Dichloride Diphenyl–Trichloroethane
DHS	Demographic Health Survey
FMOH	Federal Ministry of Health
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Nets
LLINs	Long Lasting Insecticidal Nets
MARA	Mapping Malaria Risk in Africa
MARC	Myanmar Artemisinin Resistance Containment
NMCP	National Malaria Control Program
P–VALUE	Probability Value
P. f.	*Plasmodium falciparum*
P. v.	*Plasmodium vivax*
PMI	President's Malaria Initiative
RBM	Roll Back Malaria
SPSS	Statistical Package for the Social Sciences
SSA	Sub – Saharan Africa
UNICEF	United Nation International Children's Education Fund
USAID	United States Agency for Internal Development
WHO	World Health Organization
WMR	World Malaria Report

Table of Contents

List of Figures

List of Tables

Abstract

Malaria is a major health and socio-economic problem in developing countries of the world including Ethiopia. This study was aimed to determine the prevalence of malaria infection in patients who visited Dubti Health Center for the last five years (2006 – 2010 E.C). A retrospective study was conducted to determine the prevalence of malaria infection from laboratory registered records in Dubti Health Center and 274 household heads were purposely selected from Kebele 01 of Dubti town and rural Kebele Ayrolaf to assess the knowledge, possession and utilization of mosquito nets. Examination for malaria parasites was carried out using light microscope and rapid diagnostic test. Structured questionnaires were administered to gather relevant information on socio-demographic, associated risk factors of malaria infection, possession and utilization of mosquito nets in households. Data were entered and analyzed using Microsoft Excel 2010 and SPSS version 20. Prevalence of the disease was 9.1% *and* 3.3% *in males and females, respectively. During the past five years, a total of 47,651 thick and thin Giemsa stained blood films were examined for malaria diagnosis in Dubti health center and 4153 (8.7%) microscopically confirmed malaria cases were reported with slightly lower in magnitude from 2006 to 2009 E.C, and slightly increased in 2010 E.C. The overall prevalence of malaria infection was 8.7 %. Prevalence of Plasmodium falciparum, Plasmodium vivax and mixed infection of the two were 91.3%, 8.6%, and 0.2%, respectively. Prevalence of the disease was 62.6% and 37.4% in males and females, respectively. Mixed infection was observed in age groups of 5- 14, and ≥15 years old. The association of prevalence of malaria infection with sex and age was statistically significant ($P < 0.05$). The apparent fluctuation of malaria trends in the area and the highest peak of malaria cases were reported during the month of February in the last five years. Malaria prevalence was 12.4% and the knowledge of malaria transmission and control was good. The concerned bodies should inspect, follow-up and create awareness of the community about the use of mosquito net for the intended goal in the study area.*

Key words: Dubti, malaria prevalence, mixed infections, Mosquito nets, *Plasmodium* species

1. Introduction

1.1. Background of the study

Malaria is caused by protozoan parasites belonging to the genus *Plasmodium,* which consists of five species: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi* infect humans (WHO, 2012). It is a major public health and medical concern in many parts of the world, especially in countries of tropics and subtropics. It also occurs in temperate climate (Dash *et al.*, 2007; Stratton and O. Nall, 2008; Kaur, 2009).

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

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

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

Malaria outbreak was reported in some regions (Beffa *et al.*, 2015). Of the country malaria is seasonal with periodic transmission that lends to the outbreak of an epidemic. In Ethiopia, malaria transmission is largely determined by climate and altitude. Most of the transmission occurs between September and December, after the main rainy season from June to August while the second minor transmission period from April to May, following a short rainy season from February to March, FMOH (2008).

Therefore, the purpose of this study was to determine the prevalence of malaria in Dubti Health Center records and also believed to contribute towards reduction of malaria prevalence by improving knowledge about malaria and its control activities. So it can provide information which predominant species of *plasmodium* dominating in the study area.

1.2. Statement of the problem

Malaria is one of the most common diseases in Dubti Woreda that affect the population who are frequency vulnerable due to favorable environmental conditions for mosquitoes to breed. Conditions conducive to both vector and parasite development that result from the main rains and presence of Awash River for irrigation of sugar cane plantations and hot environmental climatic conditions prevail in the area. The prevalence of malaria has not been studied and there is no data on malaria infection in the present study area. Therefore, the study aimed to examine prevalence of malaria infection. In addition, there is growing interest in using ITNs as one of the leading strategies for the prevention and control of malaria. Hence, the study was also designed to examine whether mosquito nets are being possessed and properly utilized by the community.

1.3. Objectives

1.3.1. General objective

- To identify and determine the prevalence of malaria, associated risk factors and proper utilization of mosquito nets.

1.3.2. Specific objectives

1. To determine the prevalence of malaria infection.
2. To investigate the most dominant *Plasmodium* species in the study area.
3. To identify socio-economic factors that increases the risk of malaria infection.
4. To evaluate possessions and proper utilization of insecticide treated nets in households

1.4. Significance of the study

Determining the prevalence of *Plasmodium* species infection and identifying associated potential risk factors, and assessing the possessions, proper utilization of insecticide treated nets are important parameters required in the institutional control programs. Therefore, the data obtained from this study would help the Afar Regional and Woreda Health Bureaus to design the necessary prevention and control measures against malaria infections. The findings of this study can be used by other researchers who are interested to do further study.

2. Review of Related Literature

2.1. Global Epidemiology and Geographic Distribution of Malaria

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

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

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

Moreover, widespread poverty, lack of infrastructures and resources necessary to mount sustainable interventions against the disease in the continent play a role in the continuing burden of malaria (Teklehaimanot and Mejia, 2008). Most of the deaths due to malaria occur in African children under the age of 5 years, who have little or no immunity to the disease and in every 40 second a child dies of malaria, resulting in a daily loss of more than 2000 young lives worldwide (Tamura *et al*., 2010). Pregnant women and their unborn children are also at great risk for malaria because the immune response is suppressed in pregnancy and parasitized red blood cells (RBCs) sequestered in the placenta (Vangapandu *et al.*, 2007).

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

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

According to WHO (2016) report between 2010 and 2015, malaria incidence rates (new malaria cases) fell by 21% globally. During this same period, malaria mortality rates fell by an estimated 29% globally and by 31% in the African Region. Other regions have achieved impressive reductions in their malaria burden. Since 2010, the malaria mortality rate declined by 58% in the Western Pacific Region, by 46% in the South-East Asia Region, by 37% in the Region of the America and by 6% in the Eastern Mediterranean Region. In 2015, the European Region was malaria-free: all 53 countries in the region reported at least 1 year of zero locally-acquired cases of malaria (WHO, 2016). About 4% of estimated cases globally are due to P. vivax, but outside the African continent the proportion of *P. vivax* infections is 41% and 96% estimated due to *Plasmodium falciparum* globally(WHO, 2016).

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

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

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

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

2.2. Pathogenesis and Life cycle of *Plasmodium* species

The *Plasmodium* species which cause human malaria are *P. falciparum, P. vivax, P. ovale* and *P. malariae* all of which are transmitted by the female *Anopheles* mosquitoes. Despite variations within the different *Plasmodium* species, symptoms of malaria are generally non–specific and most commonly include fever, shivering, headache, nausea, vomiting, muscle aches and fatigue. These can rapidly progress to organ failure, delirium convulsions, coma and too often death if not treated promptly (Bell and Winstanley, 2004). Even though all the four *Plasmodium* species are causing human malaria, there have been differences in the severity of the disease they cause depending on the species of *Plasmodium* species. For example, infection by any of the four *Plasmodium* species may cause illness, but infection wit*h P. falciparum* if not treated promptly may lead to death. *Falciparum* malaria begins as a disease that is indistinguishable from *vivax* malaria but, unlike *vivax*, *falciparum* malaria can progress to a range of life-threatening manifestations if untreated (Clark and Cowden, 1999).

The occurrence of malaria depends on adequate rainfall and temperature (Woyessa *et al.*, 2012). At 20-30 °C, malaria parasites develop optimally in the vector, and the parasites cease to develop in the mosquito when the temperature falls below 16 °C. High humidity prolongs the life of the vector and transmission is extended under these conditions. In the human intermediate host, the parasite must function at 37 °C or higher, since the infection induces a significant rise in core temperature during the height of the infection (Sutherest, 2004).

Although, the four major species of *Plasmodium* differ in some ways from each other, they all share the same complex life cycle involving the insect (mosquito) vector and the human host (Figure 1).

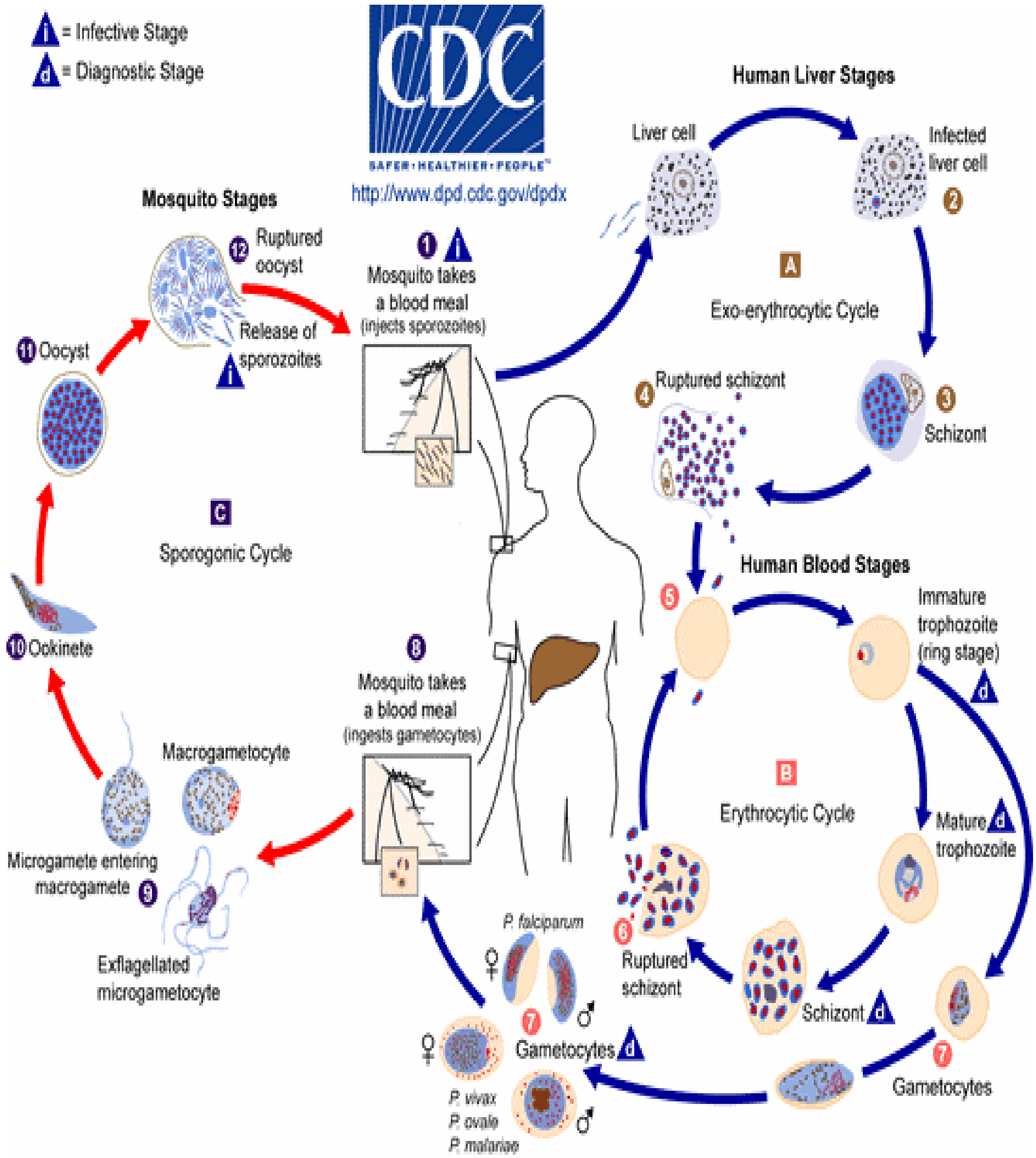

Figure 1: Life cycle of *Plasmodium* species.

Source: *CDC http:// www.dpd.cdc.gov/dpdx/HTML/Malaria.htm*

When an infected *Anopheles* mosquito bites a human, sporozoites are injected with the saliva. After entering the circulatory system, the sporozoites make quick work of invading liver cells (hepatocytes) using the apical organelles (characteristic of all apicomplexans).

After being introduced into the human intermediate host, it enters the bloodstream and is carried to the liver.

Once in the liver, the sprozoites penetrates hepatocyte and undergo growth and multiplication. In the case of *P. vivax* and *P. ovale*, some sporozoites transform to dormant hypnozoites, remaining viable for up to 50 years (Krotoski *et al*., 1982). This stage is responsible for relapses when it re-enters their developmental cycle. Inside the host's liver cells the *Plasmodium* parasites undergo asexual replication. After 9-16 days they return to the blood and penetrate the red cells, where they multiply again, progressively breaking down the red cells. This induces bouts of fever and anemia in the infected individual. In cerebral malaria, the infected red cells obstruct the blood vessels in the brain. Other vital organs can also be damaged often leading to the death of the patient (Lambert, 2005).

P. falciparum, which causes the most virulent human malaria, is responsible for approximately one million deaths annually (Rahmatullah *et al*., 2012). *P. falciparum* has the ability to invade red blood cells of all ages, and with repeated cycles of development within the red cells, the parasite numbers exponentially grow in to very high parasite burdens if infection is uninhibited by treatment or host immunity (Ndiaye *et al.*, 2012).On the contrary, *P. vivax* preferentially infects only young red blood cells, thus limiting its reproductive capacity and resultant parasite loads. Thus, the parasite load in *P. falciparum* infections can be very high, even exceeding 20–30% where as in *P. vivax* malaria is rarely exceeds 2%, even in case of severe disease (Louis and George, 2005). Recently, *P. vivax* has been shown to be not as big as it was previously thought and is associated with complications, such as severe anemia, respiratory distress, malnutrition, and even coma .In addition, *P. vivax* has been found to be a major cause of morbidity in young children. Besides, *P. vivax* can cause relapses due to the presence of long-lived latent forms in the liver, known as hypnozoites. Without radical treatment to remove the hypnozoites, patients may suffer relapses.

Malaria related morbidity and mortality in sub–Saharan Africa presents a significant obstacle for economic development in this part of the world. Although, a number of chemotherapeutic options are available for treating *P. falciparum* malaria, the rapid spread of drug resistance has marginalized the utility of many of these drugs (Kokwaro, 2009).

Almost 40% of the world's population is currently exposed to *P. vivax,* with 130–435 million clinical episodes recorded each year (WHO, 2010). The emergence of multi-drug resistant *P. vivax* isolates associated with severe and fatal malaria highlights the need to consider both *P. vivax* and *P. falciparum* when implementing measures designed to reduce the burden in regions both species coexist. It has frequently been reported that *P. vivax* suppressed *P. falciparum* and ameliorated disease severity in patients infected with these two species simultaneously. Immunological responses stimulated by *P. vivax* may play a role in suppressing co-infecting *P. falciparum*. Collectively, these results suggest a possibility that *P. vivax* infections may suppress *P. falciparum* in multiple ways including cross-reactive IgM and cytotoxicity-inducing cytokines (Nago *et al.,* 2008).

2.3. Global Distribution of *Plasmodium* Species infections

Malaria is a parasitic disease caused by protozoan parasites of the genus *plasmodium* and transmitted by female *Anopheles* mosquitoes. It affects the population of tropical and subtropical areas of the world, as well as an increasing number of travelers to these of destinations. Four species of the genus *Plasmodium* cause malaria in human of these; *P. falciparum* causes the most deadly, widespread and severe malaria (Breman *et al*., 2006). However, on the globe, it extends up to 60° north and 40° south of latitudes. Its distribution in the world is not uniform. Different species of *Plasmodium* are found in different countries (WHO, 2011). The global malaria burden is not evenly distributed with Sub-Saharan Africa accounting for 90% of global malaria cases and a majority of these cases occurring among women and children (Audrey *et al*., 2008).

Africa experiences a complete spectrum of malaria epidemiology ranging from intense perennial transmission to unstable epidemic prone areas (MARA, 1998). The overwhelming bulk of the world's malaria burden rests upon the population of sub–Saharan Africa because of the unique coincidence of expanding human populations, weak health systems, the world's most efficient vector mosquito species and environmental conditions ideal for transmission. (Kiszewski and Awash 2004) stated that malaria epidemics caused by changes that enhances the development or survival of vector mosquitoes including changes in the landscape, breakdowns in intervention programs, or insecticide resistance.

Malaria accounts for up to 60% of all health facility visits in the Eastern African region. However, due to poor health care coverage and other factors, much of the malaria–related illness and death actually occurs in the home, therefore, going unreported. The disease epidemics affect non–immune populations in many highland and semi–arid areas of the continent. It frequently occurrence of drug resistance parasites and insecticide resistant vectors ,change in the resting behavior of mosquitoes (from indoor to outdoor) as a result of frequent indoor insecticide sprays, lack of efficient infrastructure, shortage of trained manpower, lack of appropriate management and inability to integrate several methods of control (Toure, 2001; Howard *et al*., 2007).

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

A substantial reduction in malaria transmission has been achieved globally, particularly in endemic countries between 2000 and 2012. Over this period, the malaria mortality rate was reduced by 42% in all age groups and by 48% in children under five years of age (WHO, 2015). Approximately 3.3 million death were prevented between 2001 and 2012, of which 91% were children under five years of age in Africa. The reduction was mainly associated with scaled up support by international donors, socioeconomic developments, the deployment of artermisin in based combination treatment, wider courage of long lasting insecticidal nets (LLINs) and indoor residual spraying in malaria's areas (WHO, 2013).

According to WHO (2016) report between 2010 and 2015, malaria incidence rates (new malaria cases) fell by 21% globally. During this same period, malaria mortality rates fell by an estimated 29% globally and by 31% in the African Region. Other regions have achieved impressive reductions in their malaria burden. Since 2010, the malaria mortality rate declined by 58% in the Western Pacific Region, by 46% in the South-East Asia Region, by 37% in the Region of the America and by 6% in the Eastern Mediterranean Region. In 2015, the

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2.4. Malaria prevalence in Ethiopia

Ethiopia has achieved remarkable progress in the fight against malaria during the most recent decade through strong 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 (Barnes *et al.*, 2009). In children under five years of age, malaria admissions and deaths fell by 81% between 2001 and 2011 and 73% respectively. The country is also one of the sub-Saharan countries that have shown progress in the fight against malaria and in attaining the MDG6C, half and begin to reverse the incidence of malaria and other major diseases by 2015 (FMOH 2015). WHO has been actively supporting the Federal Ministry of Health of Ethiopia (FMOH) in the fight against malaria. Among other contributions, WHO has been providing technical support in building the capacity of health of workers, programme monitoring review and evidence generation, resource mobilization, supportive supervision at all levels, as well as supporting the revision and updating of strategic documents and guidelines. FMOH and WHO have also jointly developed a new stratification map using health facility based surveillance data (WHO, 2015).

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 cycle of vector-borne infections 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).

Malaria is a life threatening caused by *Plasmodium* parasite infection. Malaria is the most deadly, and it predominates in Africa (Abebe, 2014). The problem of malaria is very severe in Ethiopia where it has been the major cause of illness an under 5 (Aregawi *et al.*, 2014). That is more than 50 million people are at risk from malaria (WHO, 2008), and four to five million people are affected by malaria annually (WHO, 2015). The transmission of malaria in Ethiopia depends on altitude and rainfall with a lag time varying from a few weeks before the beginning of the rainy season to more than a month after the end of the rainy season (WHO, 2008). Epidemics from malaria are relatively frequent (WHO, 2010) involving highland or high and fringe areas of Ethiopia mainly areas 1000-2000 meters above sea level (Darymple *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. Major epidemics occur every five to eight years with focal epidemics as the commonest form (Getachew *et al.*, 2007). In general, the trend of malaria in Ethiopia over the last two decades has been increasing. The high influx of non–immune people into malaria endemic areas for social and economic reasons such as resettlement and search for alternative income, and the expansion of agricultural and industrial developments in malarious areas of the country could be some of the reasons for the observed rise in the number of malaria cases during these periods. Intervention strategies such as scaling–up of mosquito net implementation, community mobilization for elimination of mosquito breeding sites and proper targeting of indoor residual spraying of houses are critical in reducing the consequences of malaria (Adhanom *et al*., 2006).

2.4.1. Malaria Prevalence in Afar Region

According to official statistics, the region's population is about 1.5 million; of which 90% are pastoralists and 10% are agro-pastoralists (CSA, 2005). The overall health status of the Afar population is poor, with women and children particularly susceptible to poor health maternal mortality (720/100,000) and less under-fives years child mortality (229/ 1000) are double the national average (WHO, 2010). Malaria transmission in the region is perennial due to the availability of large perennial river bodies and hot climate favoring the transmission throughout the year, with seasonal peak extending from August to December (AMREF, 2011; Daddi and Abebe, 2012). The region is also prone to natural disasters such as droughts and floods and these have in the past contributed to increased malaria transmission, particularly along the banks of Awash River. Since the last decade, flooding of Awash River is on the increase, creating ideal conditions for vector breeding (AMREF, 2011). *P. falciparum* (about 65%) and *P. vivax* (about 35%) are the two dominant malaria parasites prevailing in the region (Alemu, 2015; WHO, 2015)

2.5. Factors Affecting the Transmission of Malaria

Transmission of malaria depends on the factors affecting the disease and varies from place to place. There are areas where the transmission and incidence of disease is high, low and in some areas it is very brief that it lasts for several months or throughout the year. Different climatic and non-climatic factors favor the transmission of the disease. Temperature, rainfall and relative humidity are the climatic variables that influence parasites life cycle in vector as well as in parasites (Gubler *et al.*, 2001; Koenraadt *et al.,* 2004). Non-climatic factors include parasites, vectors, human host factors, population movement or migration, urbanization and interruption of control and preventive measures.

2.5.1. Climatic Factors

Climate change represents a potential environmental factor affecting disease emergence. Shift in the geographic ranges of hosts and vector, effect reproduction, development, and mortality rates on hosts, vectors, and pathogens. Effects of the increased climate variability, floods and droughts all have the potential to affect disease incidence and emergence either positively or negatively. Divya *et al.,* (2013) explained the associations between total, average rainfall and malaria outbreaks. Mosquitoes prefer water bodies and right amount of rainfall is most important factor for them to breed. So, changes in rainfall drive malaria transmission to a higher state (Gao *et al.,* 2012). Blanford *et al.,* (2013) explained temperature as an important determinant of malaria transmission. Maximum and minimum temperatures affect the life cycle of malaria parasite. The maximum and minimum temperatures for parasite development are 40°C and 18°C. Below 18°C, the life cycle of P. *falciparum* in the mosquito body is limited. The minimum temperature of *P. vivax* are between 14–19°C, surviving at lower temperatures than *P. falciparum*. Life cycle of the parasites in vectors can be shorter or longer depending on temperature. A minimum of 10 to 19 days is required for the parasite to complete its life cycle in the gut of mosquito.

Sometimes life cycle decreases to less than 10 days as the temperature increases from 21°C to 27°C, with 27°C being the optimum. Malaria transmission in areas colder than 18°C can occur because the Anopheles often live in houses, which tend to be warmer than the outside temperature. Mosquito's survival is greatly influenced by relative humidity as they survive better and become active under conditions of high humidity greater than 60%, if it is below 60% the life cycle of mosquito is short or no malaria transmission. Therefore, rainfall, temperature and relative humidity are the major climatic factors that guide malaria transmission by showing their effect on Anopheles mosquitoes. Statistical methods like correlation (Kim and Jang, 2010), time series analysis (Tian *et al.*, 2008), regression methods (Robert, 2012) were used to understand association between climate and malaria disease and also the effect of climate on malaria disease incidence and transmission. Most of the studies used either individualistic or combined effects of all the three climatic factors on malaria incidence. Studies on climatic variability and its influence on malaria disease in Mahaboobnagar district, Andhra Pradesh, India demonstrated that monthly temperature, rainfall, humidity and mosquito populations (*Anopheles culicifacius, A. fluviatalis, A. subpictus* and *A. stephensi*) showed positive correlation with monthly malaria disease incidence (Srinivasulu *et al.,* 2013).

Correlation analysis between malaria cases and various meteorological variables (total rainfall, mean of maximum and minimum, and relative humidity) showed positive correlation with monthly incidence of malaria. Mathematical models were developed nearly a century ago and are well established (Macdonald, 1957). A validated spatiotemporal modeling of malaria transmission, three climatic scenarios reported (Mabaso *et al.,* 2006), the impact of climate change on malaria disease incidence and transmission (Parham and Michael, 2010).

Development of valid and realistic models that capture climate change on malaria disease and vector populations remains important research area and a crucial component towards improving the understanding on malaria transmission across a range of environmental changes. Reliability of such models is estimated by forecasting methods and by comparing the past data with the present data and predicting the future risks of the disease incidence rat

2.5.2. Urbanization and Intensity of Malaria Transmission

Ethiopia and other countries in the SSA are characterized by rapid urban population increase, particularly in areas where the highest rates of *P. falciparum* are common (Keizer *et al*., 2004; Robert *et al*., 2003). There are two possible explanations about malaria transmission increase in urban areas. The first explanation argues that urban areas seem to have lower rates of malaria probably due to the effects of pollution on mosquito breeding habits and reduction of man–vector contact with vector control measures such as house screening, insecticides and mosquito nets (Robert, 2003). The second explanation stems from the idea that urban environment may influence malaria transmission often by providing ample mosquito breeding habitats like broken or blocked water drains, new construction activities, irrigation schemes and new water collection reservoir (Keizer *et al*., 2004; Robert *et al*., 2003). As a result, the importance of urban malaria has been recently recognized as one of the major health problems for the urban community.

The total number of people living in urban areas has increased from 1.9 million in 1965 to 12.5 million in 2005. Urban population growth is partly fueled by internal migration, migration from rural to urban areas increased during the 1980s and 1990s (CSA, 1991; 1996). Most of the significant increase in the number of the population in urban areas in Ethiopia occurs in lowland areas where the risk of malaria infection is very high. This is confirmed by characterization of lack of proper sanitation, poor drainage of surface water, weak health services and widespread economic disparity (Keizer *et al.*, 2004). All these factors, independently or together, facilitate urban malaria transmission.

Malaria transmissions in urban areas result in large variations in malaria prevalence in different parts of the towns. A 5.3% prevalence of malaria, of which 74% due to *P. falciparum* malaria, was reported mainly among people living near mosquito breeding sites in Gondar town in 2004 (Tilaye and Deressa, 2005). In Adama, an overall parasite rate of 2.8% was observed among 3,890 individuals examined with a much higher prevalence in the peripheral areas, and these differences were reflected in the abundance of mosquito density (Yohannes and Petros, 1996). Therefore, understanding urban factors that facilitate or inhibit malaria transmission is important for planning malaria control interventions in urban areas.

2.5.3. Insecticide Resistance in malaria vectors

Since 2000, progress in malaria control has resulted primarily from expanded access to vector control interventions, particularly in sub-Saharan Africa. However, these gains are threatened by emerging resistance to insecticides among *Anopheles* mosquitoes. According to the latest World Malaria Report, 68 countries reported mosquito resistance to at least 1 of the 5 commonly-used insecticide classes in the period 2010-2017; among these countries, 57 reported resistances to 2 or more insecticide classes (WMR, 2018).

Despite the emergence and spread of mosquito resistance to pyrethroids (the only insecticide class used in ITNs), insecticide-treated nets continue to provide a substantial level of protection in most settings. This was evidenced in a large 5-country study coordinated by WHO between 2011 and 2016 (WMR 2018).

2.5.4. Poor Utilization of ITNs

Vector control is a key preventive strategy for malaria. Effective malaria vector control relies heavily on two core insecticidal interventions: deployment of insecticide-treated mosquito nets (ITNs) – mainly long-lasting insecticidal nets (LLINs) treated with a synthetic pyrethroid – and indoor residual spraying (IRS) of insecticides. Significant reductions in malaria morbidity and mortality since 2000 have mainly been due to the widespread implementation of these two insecticidal interventions. Resistance to the four insecticide classes commonly used in these interventions has emerged in malaria vector populations throughout the world. Of particular concern is pyrethroid resistance, because this insecticide class is used in all WHO-recommended LLINs and is also used for IRS in many countries. Although it is still unclear to what extent insecticide resistance impacts on the effectiveness of current malaria vector control tools, the emergence and spread of resistance is clearly a major threat to the significant gains made against malaria in recent years. The WHO Global plan for insecticide resistance management in malaria vectors (GPIRM) was launched in 2012 to provide a comprehensive approach to addressing this biological threat to malaria control and elimination (WHO, 2012). Among other actions, GPIRM identified a key need to establish a database to track the status of insecticide resistance in malaria vectors. In 2014, the WHO Global Malaria Programme started a global insecticide resistance database to consolidate the data reported by Member States and their development partners, and data extracted from scientific publications. This report summarizes available data on insecticide resistance in malaria vectors and the key outcomes from analyses of these data. The scope is limited to data for malaria vectors collected between 2010 and 2016, with a focus on outcomes from standard assessments, in line with WHO's Test procedures for insecticide resistance monitoring in malaria vector mosquitoes, 2nd edition (WHO, 2016b). More recent data can be accessed through the online Malaria threats map (WHO, 2017b), which allows the interactive exploration of available information from the WHO insecticide resistance database and from other databases maintained by the Global Malaria Programme.

2.6. Prevention and control of malaria

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

Fighting malaria is among the eight Millennium Development Goals. Early diagnosis and effective treatment, Vector control, easy and universal accessibility to ITNs, residual periodic spray of dwellings, environmental management, and continued efforts in epidemic prevention are currently implemented control strategies. Expanded use of information technologies, education, and communication is among the supporting strategies (Sheleme, 2007). Insecticide treated materials are important in malaria control evidence from several studies show that use of insecticide-treated materials reduced severe malaria cases in children by about 45% and all case mortality by about 20% (Sheleme, 2007). Additionally, clear operational plans including a long term vision for malaria control were formulated in which sustained scale up of proven malaria control tools would gradually lead to malaria elimination in Africa, with ultimate goal of worldwide malaria eradication by 2040-2050 (PMI, 2015). The proven malaria intervention tools being extensively used in Ethiopia are:

insecticide treated mosquito nets (ITNs); indoor residual spray (IRS); prompt diagnosis and treatment with artemisinin-based combination therapies (ACTs). Although Ethiopia is still in malaria control phase, it has set a plan to eliminate malaria in selected low transmission settings by 2020 (PMI, 2016).

2.6.1. Indoor Residual Spray (IRS)

Indoor residual spray is one of the main malaria control strategies in Ethiopia. IRS is the process of spraying the inside walls and ceiling of houses and buildings with insecticide that include DDT, Pyethroid, and deltamitrin chemicals. IRS is effective control intervention to kill adult vectors mosquitoes that land and rest on the surface of walls and roofs of house and domestic animal shelters thus in areas of intense malaria transmission the impact of IRS is highly effective strategy to combat malaria (FMOH, 2012). This method has been proved effective in minimizing malaria infection and incidence however its effectiveness is influenced by the development of some mosquitoes' resistance to some chemicals used in IRS. WHO recommends the use of combined interventions to solve the mosquitoes challenge to developing IRS resistance that could influence the control intervention when implementing malaria control programme.

The FMOH's NMCP aim to provide 100% IRS coverage as a key malaria prevention measure in area where malaria burden is high and in highland fringe areas with the potential for malaria out-breaks. The new FMOH malaria risk stratification, 14.8% of the country's total population is targeted for IRS as compared to 17% in the 2014 stratification (PMI, 2017).

2.6.2. Malaria Prevention through Artemisinin-based Combination Therapies

World Health Organization currently recommended combination drug therapies as a result of the resistance of the disease to conventional drug therapies, such as Sulfadoxine-pyrimethan, Chloroquin and Amodiaquine has increased. The ACT's recommended by WHO include Artemether Lumfantrin (AL), Artesunate-amodiaquin (AS-AQ) and artesunat-mefloquine (AS+MQ). Recent ACT's as the most effective drug treatment and they able to produce a very rapid therapeutic response to malaria. Artemisinis are highly potent, short-half-life anti malaria drugs and they act very fast 6 hours of administration and the remaining parasite load is progressively cleared by the partner drugs that usually has longer half-life and acts slowly (WHO, 2015).

2.6.3. Insecticide Treated Net

Sleeping under an insecticide-treated net (ITN) can reduce contact between mosquitoes and humans by providing both a physical barrier and an insecticidal effect. Population-wide protection can result from the killing of mosquitoes on a large scale where there is high access and usage of such nets within a community (WMR, 2018).

In 2017, about half of all people at risk of malaria in Africa were protected by an insecticide-treated net, compared to 29% in 2010. However, ITN coverage increased only marginally in the period 2015 to 2017 (WMR, 2018).

2.7. Ownership and Utilization of Mosquito nets in Ethiopia

Insecticide-treated bed net (ITN) is one type of cost-effective vector control approach for the prevention of malaria and it has to be treated with insecticide and needs ongoing treatment. It implies that using ITN is very helpful way in the prevention of malaria transmission in highly endemic areas (WHO, 2011). The WHO Global Malaria Programme has recommended full coverage of long-lasting insecticidal nets (LLINs)/ITNs for malaria prevention (WHO, 2015). Myanmar also promotes the use of bed nets (ITNs) through the free delivery of LLINs and free treatment of mosquito nets already in use before the start of the peak transmission season. The goal is that at least 80% of people in moderate and high-risk areas are protected by ITNs/LLINs (FMOH, 2009). Previous studies among the general population in Myanmar or among selected migrant groups such as the rubber plantation workers have shown the poor utilization of ITN/LLINs (Nyunt *et al.*, 2014; Liu *et al.*, 2015).

In Ethiopia, the prevalence of malaria during pregnancy varies from 6.1% to 10.4%, which is a public health problem. But, this terrible problem can be eliminated or reduced by appropriate utilization of insecticide treated nets for all pregnant women (Debo, 2016; R.D. Newman *et al.*, 2003). Using of appropriate ITNs is considered as a key in reducing the adverse effects of malaria during pregnancy among the vulnerable populations. The effective use of effective ITN is shown to reduce malaria transmission by 90% and miscarriages and stillbirths by 33% (WHO, 2017; Omer *et al.,* 2017).

In order to control this high burden of malaria during pregnancy, the Federal Ministry of Health has distributed 29.6 million long-lasting insecticidal nets (LLINs) which represent 60% of the total population (FMOH and UNICEF, 2016). Even if the magnitude of malaria during pregnancy is high and there are different strategies to decrease the risk of malaria for vulnerable groups, many articles revealed that the use of ITNs by the pregnant woman in Sub-Saharan countries including Ethiopia is very low (Debo, 2016). And this low utilization of ITNs by pregnant women is affected by education status, occupation, residence, ownership of television or radio, religion, ethnicity, age, and family monthly income (Belay, 2008).

Therefore, the distribution of LLITNs per household in the study areas was lowest and most households had a single net for on average two individuals shared. Most parts of the study area are epidemic prone and households require extra nets to reduce the occupant per net gap in order to attain sustainable control of the disease.

3. Materials and methods

3.1. Descriptions of the study area

The study was conducted in Dubti Woreda. The Woreda is found at 620 km from Addis Ababa and 12 km from the capital city of the region, Samara. The Woreda has an estimated total population of 87,197, of whom 36,281 were males and 50,916 were females; 24,236 or 27.79% of its population are urban dwellers, which is greater than the Zone average of 14.9% (CIA, 2007). With an estimated area of 3601.4 square kilometers, Dubti has an estimated population density of 24.21 people per square kilometer (CSA, 2005). Annual mean rainfall is 100.3 mm, the rain fall has bimodal distribution July-August (main rainy season) and February - April (short rainy season) and hot temperature with mean annual temperature is 30.1^{0}C (source, Samara Metrological Station, 2017). The average elevation in this woreda is 503 meters above sea level the highest point in Dubti is Mount Manda Hararo (600 meters) (Hailu, 2011). Rivers include the Awash River, which splits the woreda into northern and southern parts, and its tributary the Logiya. Alongside the Awash are the Dubti Marshes, which cover an area 34 by 12 kilometers, and whose dominant vegetation is *Phragmites* (Robert *et al.,* 1992). A sample enumeration performed by the CSA in 2001 interviewed 1676 farmers in this woreda, who held an average of 0.72 hectares of land. Of the 1.21 square kilometers of private land surveyed, 28.15% was under cultivation, 64.53% fallow, 3.46% was devoted to other uses (C.S.A, 2007). Although the percentage in pasture or woodland was missing from the CSA enumeration, a later survey reported 0.5% of the woreda had tree cover (Hailu, 2011). For the land under cultivation in this woreda, 27.9% in planted in cereals like maize; none of the land was planted in pulses and vegetables. All of the farmers reporting only raised livestock. For land tenure in this woreda, 94% own their land; the figures for those renting or holding land under other forms of tenure are missing (C.S.A, 2007).

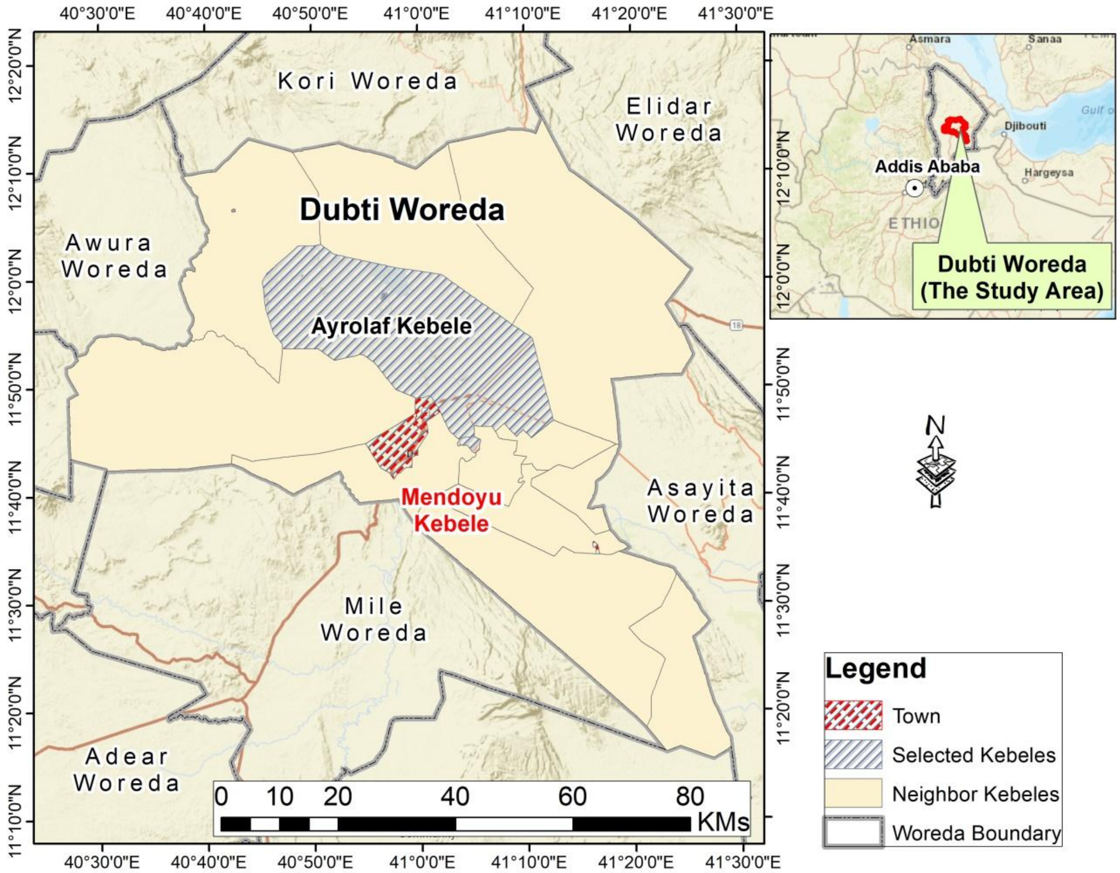

Figure 2: Map of the study area, Dubti Woreda, Afar Region Northeast Ethiopia.

3.2. Study Design and Study Population

A retrospective study was conducted to determine the five year trend in prevalence of malaria cases by reviewing blood film malaria report of registered data at Dubti Health Center, and a cross sectional study was also used to determine the prevalence of *Plasmodium* species infection from outpatients with malaria symptoms who visited in Dubti Health Center. The age ranged from 15 year to 70 years of old. Household heads were interviewed on possession and utilization of mosquito nets in *Kebele* 01 of Dubti town and rural *Kebele* namely Ayrolaf.

3.3. Sample size

Sample size was estimated using statistical formula n = $\frac{p(1-p).z^2}{d^2}$ (Naing *et al*., 2006) where n = required sample size, z = confidence level at 95% which is standard value of 1.96, p = estimated prevalence of malaria and d = marginal error at 5%, standard value of 0.05. Since, the overall prevalence of malaria was not known for the study area, prevalence (p) was taken to be 50% and this give the minimum sample population of 384.

$$n = \frac{p(1-p).z^2}{d^2}$$

$$= \frac{0.5(1-0.5)\ X\ (1.96)^2}{(0.05)^2}$$

$$= \underline{384}$$

However, due to resources constraints 274 outpatients that visited the health clinics had been taken for malaria prevalence study. Concerning on possessions, proper utilization of mosquito nets, 274 households' heads that were selected randomly had been questionnaires.

3.4. Data Collection Procedures and Techniques

In this study, malaria patients medical history document review/archival/ was made from year 2006 to 2010 E.C to obtain the pertinent data for the study to assess the prevalence of malaria disease in at Dubti Health Center. Retrospective data were collected from patient's medical history registration records.

3.4.1. Retrospective Malaria data Collection

Five year malaria prevalence data was obtained from Dubti Health Center. In this health center peripheral smear examination of a well prepared and well stained blood film is used as the gold standard in confirming the presence of malaria parasite as WHO protocol. Therefore, for this study purpose, a five years (2006 – 2010 E.C) malaria data was collected from Dubti Health Center from September – November 2018 E.C.

3.4.2. Blood film microscopic examination for malaria parasite

A total of 237 patients visited the outpatient Department of Health Clinics from September – October. Blood film collection was carried out by laboratory technician. Before collecting blood sample for malaria diagnosis, the finger was cleaned with alcohol moistened cotton, dried with dry cotton, and then punctured using sterile disposable lancet. The thick and thin blood smears were prepared on a slide and patient identification numbers were marked on the thin films by a pencil. All slides were stained with 3% Giemsa stain and fixed for 30 minutes. Each blood smear was observed under the oil immersion objective of the microscope. The thick smear was used to determine whether the malaria parasite was present or not after observing 100 fields of vision. The thin smear was used to identify the type of *Plasmodium* species

3.4.3. Structured Questionnaire on Ownership and Utilization of Mosquito net

When laboratory diagnosis for malaria in outpatients was ongoing, questionnaires had been filled by these outpatients on socio-demographic data which include sex, age, occupation, educational status and possession, and utilization of mosquito nets and other necessary information were gathered. Questionnaires originally developed in English and translated into Amharic. For native speakers the Amharic version translated to Afar-afa by assigned translator.

Using questionnaires, heads of households in *Kebele* 01 of Dubti town and rural *Kebele* Ayrolaf were interviewed on possession and proper utilization of mosquito net.

3.5. Data analysis

Excel Microsoft 2010 and SPSS Statistics 20 for windows (SPSS Inc, Chicago USA) was used for data analysis. Pearson Chi -square test was used for Prevalence of *Plasmodium* species, socio demographic characteristics such as age, sex, and percentage was used for ownership, proper utilization of mosquito nets in household questionnaire. Statistical significance was defined at p–values less than 0.05 ($P < 0.05$).

3.6. Ethical Consideration

Addis Ababa University, College of Natural and Computational Sciences, Department of Zoological Sciences issued Ethical Supportive letter before the study was conducted. Individual verbal consent was obtained for taking blood film in sampled presents. Similarly, household heads gave verbal consent to assess mosquito net utilization at the selected houses. Only volunteer individuals were included in the study and privacy was observed during interview of the study participants (head of household).

4. Results

4.1. Retrospective Annual trends of Malaria prevalence in Dubti Health Center

Within the last five years (2006 – 2010 E.C) a total of 47,652 blood films were requested for malaria diagnosis in Dubti health center and 4,125(8.7%) microscopically confirmed malaria cases were reported (Table 1).

Among the patients there were 24,303 (51%) males and 23349 (49%) females. Out of all males examined (5.0%) 2361 were positive for *P. falciparum* and (0.4%) 207 were positive for *P. vivax* and the rest (0.02%) 9 were mixed infection (Table 1). While in the case of females (3%) 1401 were positive for *P. falciparum* and (0.3%) 147 were positive for *P. vivax* and there is no mixed infection. However, the remaining (45.6%) 21726 of males and (45.7%) 21801 of females no malaria cases were not recorded in the study period.

There was fluctuating trend of malaria within the last five years, with the minimum (5.3%) 496 number of microscopically confirmed malaria cases being reported in 2009 E.C and the maximum (11.4%) 1054 microscopically confirmed malaria cases being reported in 2007 E.C. (Figure 3).

Regarding the identified *Plasmodium* species, both species of *Plasmodium* were reported in each year with *P. falciparum* being the predominant species in the study area and *P. falciparum*, *P. vivax* and mixed infection accounted for 91.2%, 8.6% and 0.2% of malaria morbidity, respectively in the study area (Table 2).

Table 1 Prevalence of *Plasmodium* species infection in Dubti Health Center

Total examined		Malaria Positive cases					
		P. falciparum		*P. vivax*		Mixed	
Male	Female	Male	Female	Male	Female	Male	Female
24303 (51%)	23349 (49%)	2361 (5%)	1401 (3%)	207 (0.4%)	147 (0.3%)	9 (0.02%)	0 (0.0%)

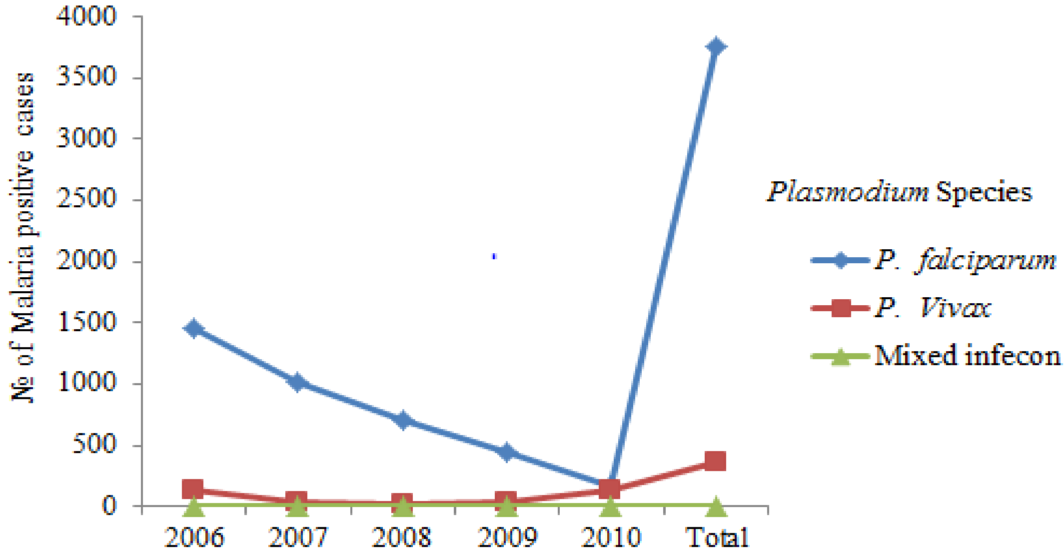

Figure 3 Annual Prevalence of Malaria in Dudti Health Center from 2006 – 2010 E.C

4.2. Prevalence of Malaria parasites in different Age groups in Dubti Health Center

According to the data malaria positive case was reported in all age groups in the area but the age groups of ≥ 15 years were more affected, with the prevalence rate of 2524 (61.2%) followed by 5 – 14 year old and < 5year olds with the prevalence rate 919 (22.3%) and 682 (16.5%), respectively (Table 2).

Table 2 Prevalence of malaria in different age group in Dubti Health Center

Age	*Examined №*	*P. falciparum*	*P. vivax*	*Mixed*	Total	P. value
< 5	9569	609 (14.8%)	73 (1.8%)	0	682 (16.5%)	
5 – 14	16975	851 (20.6%)	66 (1.6%)	2 (0.04%)	919 (22.3 %)	
≥ 15	21107	2302 (55.8%)	215 (5.2%)	7 (0.2%)	2524 (61.2 %)	0.003
Total	47652	3762 (91.2%)	354 (8.6%)	9 (0.2%)	4125(100%)	

4.3. Prevalence of Malaria by sex at Dubti Health Center

Out of the total examined patients, male 24303 and female 23349, the malaria slide positive male were 2577 (62.5%) and female were 1548 (37.5%). The prevalence of malaria infection between male and female was statistically significant (P =0.009) as shown in figure 4 below.

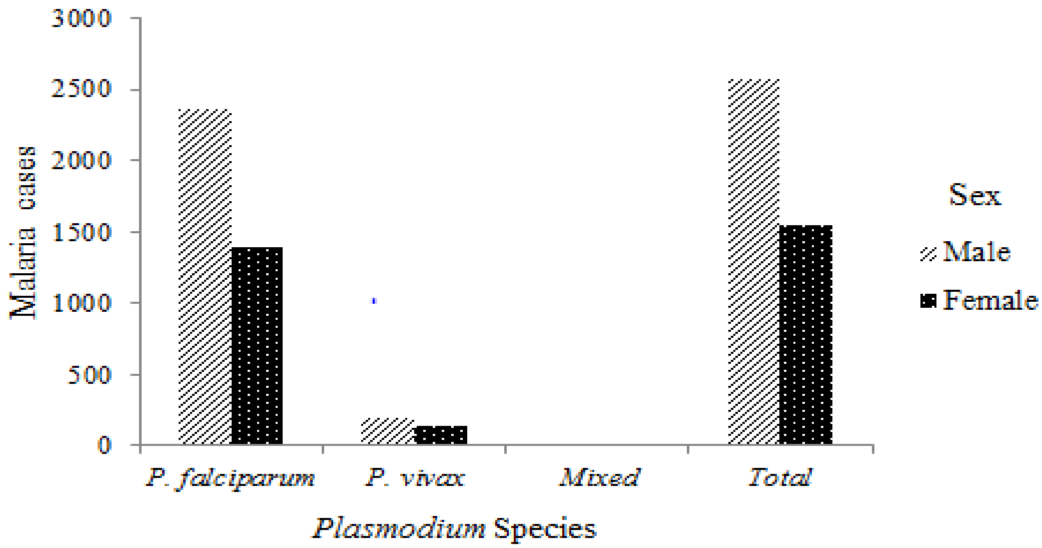

Figure 4 Gender related prevalence of *Plasmodium* species infection in Dubti Health Center

4.4. Seasonal variation of Malaria Prevalence in Dubti health center

Despite the apparent fluctuation of malaria trends in the study area, malaria cases occurred in almost every month and season of the year. The highest peak of malaria cases in almost all years was observed during December – February and the minimum malaria cases were observed during September – November. At specie level, the maximum numbers of cases of *P. falciparum* were observed in December – February, but the maximum numbers of cases of *P. vivax* were observed in December – February, followed by June – August and in both species the minimum numbers of malaria cases were observed during September – November (Table 3).

From below Table 3, Chi-Square Tests of malaria infections, by Month of malaria infections reflected among Dubti Health Center, in September *Plasmodium falciparum* resulted by 36 (1.1%), *Plasmodium vivax* infection resulted to 17 (0.5%) and mixed infection 1 (0.03%). In October month malaria is spread *Plasmodium falciparum* resulted by 84 (2.2%), *Plasmodium vivax* infection resulted to 15 (0.4%) and mixed infection 2 (0.1%).

In November *Plasmodium falciparum* infection resulted to 89 (2.3%), *Plasmodium vivax* resulted by 18 (0.5%) and mixed infection 3 (0.1). In December, *Plasmodium falciparum* infection resulted by 404 (8.7%) and *Plasmodium vivax* resulted by 26 (0.6%). In January, *Plasmodium falciparum* infection resulted by 843 (14.3%), *Plasmodium vivax* resulted by 56 (0.9%) and mixed infection 2 (0.03%).

In February, *Plasmodium falciparum* infection resulted by 903 (17.0%), *Plasmodium vivax* resulted by 56 (0.9%) and mixed infection 1 (0.02%). In March, *Plasmodium falciparum* infection resulted by 191 (5.0%) and *Plasmodium vivax* resulted by 21 (0.6%).

In April, *Plasmodium falciparum* infection resulted by 705 (16.5%) and *Plasmodium vivax* resulted by 29 (0.7%). In May, *Plasmodium falciparum* infection resulted by 196 (6.1%) and *Plasmodium vivax* resulted by 32 (1.0%). In June *P. falciparum* infection resulted by 112 (3.5%) and *P. vivax* resulted by 34 (1.1%).

In July, *P. falciparum* infection resulted by 83 (3.2%) and *Plasmodium vivax* resulted by 19 (0.7%). August *P. falciparum* infection resulted 113 (3.1%) and *P. vivax* resulted by 20 (0.5%) at 5% significance level by. Majority of malaria infections are highly consented during winter (December, January and February).

Table 3 Monthly prevalence of malaria in Dubti Health Center from 2006-2010 E.C

Month	Total examine	Malaria positive	*P. falciparum*	*P. vivax*	Mixed infection	P. value
Sept.	3391	53 (1.3%)	36 (1.1%)	17 (0.5%)	1 (0.03%)	
Oct.	3826	99 (2.4%)	84 (2.2%)	15 (0.4%)	2 (0.1%)	
Nov.	3800	107 (2.6%)	89 (2.3%)	18 (0.5%)	3 (0.1%)	
Dec.	4634	430 (10.4%)	404 (8.7%)	26 (0.6%)		
Jan.	5915	899 (21.8%)	843 (14.3%)	56 (0.9%)	2 (0.03%)	
Feb.	5309	970 (23.5%)	903 (17%)	67 (1.3%)	1 (0.02%)	0.004
March	3812	212 (5.1 %)	191 (5%)	21 (0.6%)		
April	4264	734 (17.8%)	705 (16.5 %)	29 (0.7%)		
May	3189	228 (5.5%)	196 (6.1%)	32 (1.0%)		
June	3219	146 (3.5%)	112 (3.5%)	34 (1.1%)		
July	2575	102 (2.5%)	83(3.2%)	19 (0.7%)		
August	3647	133 (3.2%)	113 (3.1%)	20 (0.5%)		
Total	47652	4125 (100%)	3762 (92.2%)	354 (8.6%)	9(0.2%)	

4.5. Current Prevalence of malaria during the study

A total of 274 respondents participated in the study (Table 4). From the total respondents 152 (55.5%) were males and 122 (44.5%) were females. The age of respondents ranged from 15 years to 70 years, the median age of the respondents was 23.2

Out of 274 individuals examined for *Plasmodium* species, (12.4%) 34 were found to be positive for malaria parasites. In particular, the majorities (9.1%) 25 were males and (3.3%) 9 were females. The association of malaria with sex was statistically significant (P = 0.005). Out of these malaria positive (7.7%) 21 were positive for *P. falciparum*. *P. vivax* accounts (4.4%) 12 and from the total positive cases (0.4%) 1 of them had mixed infection of *P. falciparum* and *P. vivax* (Table 4).

Table 4 Distribution of *Plasmodium* species by sex in Dubti Woreda (n = 274)

		***Plasmodium* species**		
Sex	**Total Examine**	*P. falciparum* %	*P. vivax* %	Mixed %
Male	152 (55.5)	15 (5.5%)	9 (3.3%)	1 (0.4%)
Female	122 (45.5)	6 (2.2%)	3 (1.1%)	0 (0%)
Total	274 (100)	21 (7.7%)	12 (4.4%)	1 (0.4%)

4.6. Socio-demographic characteristics

A total of 274 individuals (223 from Rural *Kebele* and 51 from Urban *Kebele*) participated in the study (Table- 7). From the total respondents, 152 (55.5%) were males and 123 (44.5%) were females (Table 5). The age of respondents ranged from 15 years to 70 years, the median age of the respondents was 23.2.

The educational background of the study participants varied, ranging from illiterate to higher education. The majority (50.4%) of the participants were illiterate. On the other hand, a statistical significant between sex, occupation and educational background of the study participants (P = < 0.05) as shown in Table – 5. More males were examined from malaria than females. Some16.4% males and 7.4% females' chi-square (x^2) distribution test showed significant associated with sexes (P<0.05).

Regarding to educational status, 50.4% were illiterate and out of the total illiterate studied participants16.7% were highly infected with malaria, followed by those individuals found under the status of read and write 10.4%, elementary school 3.7%, high school and higher education 0.0% respectively. Ninety seven (35.4%) of the participants had family size > 5 and 64.6% had family size ≤ 5, in which 34.1% and 14.7% of malaria positive cases had family size > 5 and ≤ 5, respectively (Table 5).

The awareness of the study participants also assessed on whether a malaria disease is infectious from one victim to another. Hence, out of the total sample population responded to the question 231 (84.3%) of them responded and consider that malaria disease is infectious while 43 (15.7%) of them have responded as malaria disease is not infectious. Out of those with the understanding that malaria disease is infectious, the study has tried to assess their knowledge on how the disease is transmits. The finding shows that almost 231 (84.3%) of the respondents understand that malaria disease is transmitted through mosquito bites, while the remaining 43 (15.7%) did not understand how to the disease is transmitted from one victim to another (Table 5).

Table 5 Socio-demographic characteristics of respondents in Dubti Woreda (n = 274)

Socio-demographic characteristics		Malaria positive (%)	Total	x^2	P. Value
Sex	Male	25 (96.3)	152 (55.5)	7.842	0.005
	Female	9 (7.4)	122 (44.5)		
Family size	< 5	33 (34.1)	97 (35.4)	2.93	0.002
	≥ 5	26 (14.7)	177 (64.6)		
Educational status	Illiterate	23 (16.7)	138(50.4)	10.243	0.035
	Read write only	10 (10.4)	96 (35)		
	Elementary school	1(3.7)	26 (9.5)		
	High school	0 (0.0)	3 (1.1)		
	Higher institution	0 (0.0)	11 (4)		
Occupation	Daily laborers	29 (15.1)	192 (70.1)	10.364	0.035
	Merchants	1 (8.3)	12 (4.4)		
	Gov. employee	0 (0.0)	11 (4)		
	Farmers	1 (7.7)	13 (4.7)		
	Others	3 (6.5)	46 (16.8)		
Knowledge of malaria transmission	Yes	20 (8.7)	231 (84.3)	1.10	0.355
	No	37 (86.0)	43 (15.7		

Key: *P < 0.05 significant,

P = prevalence and

$\chi 2$ = Chi-square value

4.7. Possession and Utilization of ITNs

Among the participants, 97.8% had owned at least one mosquito net, whereas 2.2% did not own mosquito net. Out of the total participants 67.2% were habit to use mosquito net during sleeping time, whereas 32.8% were not habit to use mosquito net during sleeping time. Regarding the frequency of using mosquito net, 50.7% slept under mosquito net regularly, but 49.3% had used sometimes. Concerning the habit of washing mosquito net 82.1% of the participant washed the bed net when it got dirty whereas 17.9% were not wash the mosquito net. On other hands, the majority of the participant had torn mosquito net (Table 6).

Table 6 Possession and Utilization Practice of Bed net use in Dubti Woreda (n=237).

Variable	Category	Frequency	Percentage
Bed net possession	Present	268	97.8
	Absent	6	2.2
Habit of using mosquito net	Yes	184	67.2
	No	90	32.8
Frequency of using Mosquito net During sleeping	Always	139	51.9
	Sometimes	135	48.1
Habit of washing mosquito net	Yes	225	82.1
	No	49	17.9
Presence of torn mosquito net	Yes	153	55.8
	No	121	44.2

4.8. Proper use of Mosquito net

About 97.8% of household participants had owned at-least one ITNs, 2.2% of the other households had responded as they had ITNs in the past but they have lost it for unknown reason. In the study area, the percentage of households who owned 1, 2 and 3 nets were 23.7%, 60.9% and 13.1%, respectively. The majority of household heads, 48.2% (132/274) had obtain ITNs free of charge from the government, whereas 32.5% (89/274) purchased ITNs from local market and 17.6% (47/274) both purchased and donated from government (Table 9). Those who slept under one mosquito net for single, for two and three persons were 31%, 56.2% and 10.6%, respectively (Table 7).

The majority of household respondents 91.6% did not use mosquito net for other purposes, but 6.2% of household respondents used mosquito net for other purpose such as for covering of chicken house to protect their predators, covering of house fence, seedling fence and also for taking of vegetables to the market (Table 7).

Table 7 Possession and utilization of mosquito net in *Kebele* 01 of Dubti town and Rural *Kebele* namely Ayrolaf (n=274).

Variables	No (%)	Total
Residence		
Rural	223 (81.4%)	
Urban	51 (18.6%)	274 (100%)
Mosquito net ownership		
Owned	268 (97.8%)	
Not owned	6 (2.2%)	274 (100%)
Mosquito net gained		
From government	132 (48.2%)	
Per-cashed	89 (32.5%)	268 (97.8%)
Both	47 (17.1%)	
Number of mosquito net owned		
0ne	65 (23.7%)	
Two	167 (60.9%)	268 (97.8%)
Three or more	36 (13.1%)	
Use of a mosquito net during sleeping		
For one	85 (31%)	
For two	154 (56.2%)	268 (97.8%)
For three or more	30 (10.6%)	
Use of mosquito net for other purpose		
Used	17 (6.2%)	268 (97.8%)
Not used	251 (91.6%)	

5. Discussion

Malaria is a huge health problem in terms of morbidity and burden on health care facilities, accounting to higher percentages of outpatient consultations in most health facilities in different regions in Ethiopia (Wakgri *et al.*, 2003).

The overall prevalence of malaria was 8.7%. This is in agreement with a study conducted in Kombolcha Health Center where the prevalence of malaria was 7.52% (Gebrestadik *et al.*, 2018). However, in contract to this finding, the study conduct in Kola Diba showed higher malaria prevalence 39.6% (Alemu *et al.*, 2012) and Dila 16% (Molla and Ayele 2015). But, it was higher than similar study conducted in Jima (Tatek, 1994) in which the overall prevalence of malaria disease accounted 7%. This different may be due to the type of study design used, environmental factors, altitude variation and skill of the laboratory personnel to detect and to identify malaria parasites and other factors that affect malaria case occurrence in different study area.

The prevalence of malaria confirmed cases was greater in males (62.6%) than in females (37.4%). This result is similar with a study conducted in Arsi Negele in which the prevalence of malaria was greater in males than females (Memgistu and Solomon, 2015), and Metema Hospital (Getachew *et al.*, 2013) in which the overall prevalence were 57.47%: 42.57, 57.7%: 42.3% respectively. The possible reason might be of males more spend the early part of the night working in their farms where they might easily be infected by exophagous mosquito bites, whereas females do not have such risk as they normally are engaged in indoor activities or it may be the number of male participants in the study area was greater than females.

Regarding to age, all age groups in the study area were infected by malaria. Participant in the age group above 15 had the highest prevalence rate which was 61.2%. On the other hand reduction of malaria prevalence observed under the age group < 5 (16.5%). This may be due to a relatively higher outdoor exposure to mosquito bite and may be due to parental protection to their children that they sleep under the net so that they reduced exposure to mosquito bite.

The highest prevalence of *P. falciparum* and *P. vivax* was observed in age groups of greater than 15 years of old and mixed infection of *P. falciparum* and *P. vivax* was observed in age groups of 5 -14 and ≥ 15 years old. Similar study by Bayissa (2007) in Fincha Sugar Factory revealed that a relatively more malaria prevalence (2.1%) was detected in the age groups 15 years and above. The higher prevalence in the age group of 15 years and above may be explained by the inadequate coverage of household members with ITNs as each household received only 2 nets and most often only children slept inside the nets in majority of the cases, which leave the adults exposed to high risk of infection. The trends of malaria prevalence in the study area were malaria appeared more in older age groups. The prevalence of malaria in this study was statistically significant with age and malaria positive (P = 0.003).

Seasonal distribution of malaria in the study area indicated that maximum number of malaria cases in almost all year groups was observed in December, January and February. This may be due to the large scale irrigation found in the study area and the lower malaria cases reported June, July and August. This study differs from a report in Motta (Tilahun *et al.,* 2016). This difference may come due to climate variability and stagnant water pool which is suitable environment to mosquito breeding.

Based on the laboratory diagnosis of *Plasmodium* species distribution in the present study revealed that the burden of malaria in the study area3762 (91.2%) were the malaria case of *P. falciparum*, 354 (8.6%) *P. vivax* and 9 (0.2%) mixed infection of *P. falciparum* and *P. vivax*.

This study coincides with the malaria parasite distribution in Ethiopia, where *P. falciparum* and *P. vivax* are two predominant parasites distributed all over the nation and accounting for 60% and 40% of malaria cases respectively (MOH, 2012). However this also in agreement with another report conducted in Butajira where *P. falciparum* 12.4% and *P. vivax* 86.5% and mixed infection of *P. falciparum* and *P. vivax* 1.1% (Woyesa *et al*., 2012).

In this study, from September up to October 2018 a total of 274 febrile outpatients who visited the Dubti health center for seeking medical treatment. The overall prevalence of malaria was 12.4%.This is in agreement with a study conducted in Dila Health Center where the prevalence of malaria was 16% (Molla and Ayele, 2015). However, which was higher than similar study conducted in Bangladish the overall prevalence of malaria was 3.97 % (Hague *et al.,* 2009). The difference might be due to altitude difference, climate variability, sample size and skill of the laboratory personnel to detect and to identify malaria parasites and other factors that affect malaria case occurrence in different study area.

Based on the laboratory diagnosis of *Plasmodium* spices distribution of malaria, 21 (7.7%) were the malaria case of *P. falciparum*, 12 (4.4%) *P. vivax* and 1 (0.4%) mixed infection. This indicates *P. falciparum* to be the dominant species in the study area.

From the present study finding, malaria infection associated with occupation, ownership of mosquito nets, habit of using mosquito net, frequency of using mosquito net, using of mosquito net for two and three persons. Malaria positives were daily laborers, farmers, merchant, government employee, children and others. The possible reason may be inadequate distribution of mosquito nets or it may be knowledge gap.

Results from the questionnaire survey observed that 84.3% of the respondents correctly recognized mosquito bite as means of malaria transmission which is similar to the study conduct in Shewa Robit town, 85% of the respondents respond mosquito bites transmit malaria (Abate *et al*., 2013). However, it is greater than a study conducted in Assosa where 48% of the participants knew that malaria transmitted by mosquito bite (Legesse *et al*., 2007). Ethiopia currently has national strategic plan that targeted to achieve national malaria control programme, which states that by 2020, all households living in malaria endemic area will have the knowledge, attitude and practice towards malaria prevention and control (PMI, 2016). Health education through health workers and communication intervention through mass media are parts of the methods.

From the total participants 97.8% owned mosquito net, whereas 2.2% did not own mosquito net. Among those who owned net, 67.2% had a habit of sleeping under nets during sleeping time, whereas 32.8% had no habit of using mosquito net. The reason for not using nets might be lack of awareness in the prevention and control methods of malaria infection. About 51.9% of the interviewees used mosquito nets irregularly, whereas 48.1% of respondents used mosquito net always. This study also demonstrated that 23.7%, 60.9% and

13.1% of the households owned at least one, two and three ITNs per household respectively which is different from a study reported in Jiga, northwest Ethiopia, where 9%, 54.3% and 36.7% households owned at least one, two and three ITNs per household, respectively (Ayalew *et al*., 2016). Then using a mosquito net for two and three persons and irregularly might expose for malaria infection.

The majority of the respondents had used torn mosquito nets during sleeping time; this may be the reason for malaria infection. Similar study conducted by Menna *et al* (2007) many nets had been torn, especially those in rural households. The majority of respondents had washed mosquito nets when it becomes dirty.

A small proportions (2.2%) of the respondents mentioned that they used nets for other purposes other than the intended purpose such as covering of house fence, covering of seedling fence, taking of vegetables to the market and covering of biddy (chicken) house fence. Similar finding was reported by Menna *et al*. (2007). This could result from lack of awareness on the benefits of mosquito nets. Malaria infections might have been brought by absence of awareness how to use mosquito nets.

6. Conclusions and Recommendations

6.1. Conclusions

The overall prevalence of malaria infection in the study area was 8.7% and in gender related malaria prevalence where males were more infected than females. The most prevalent *Plasmodium* species was *P. falciparum*, followed by *P. vivax* and mixed infection of *P. falciparum* and *P. vivax*, respectively. Malaria prevalence was highest in the age of ≥ 15 years old (61.2%). Therefore, the trend of malaria prevalence in the study area males more infected than females and older age groups more infected.

Generally, the knowledge of the study participants on malaria was good. The coverage of LLINs in this study area was encouragingly high but the current two months malaria prospective data showed that high malaria prevalence was recorded so, malaria is still a major health problem in the study area.

Malaria infection associated with: occupation, possession of mosquito net, habit of using mosquito net, frequency of using mosquito net and using of one mosquito net for one, two, three or more persons

6.2. Recommendation

Based on the results obtained from the study, to reduce prevalence of malaria and improve the knowledge of the study area about malaria and its control, the following recommendations are made:

1. Awareness creation through public health is important to improve the proper utilization of mosquito net for community in Dubti town *Kebele* 01 and nearby rural *Kebele* namely Ayrolaf.
2. The Woreda Health Bureau and other stakeholders should inspect, follow-up and create awareness of the community about the use of mosquito net for the intended goal or purpose.
3. Malaria prevention and control methods should be strengthened in the study area.
4. There should give education on malaria prevention and control for patients who are visiting health clinics seeking treatment.
5. Community based research is necessary to document the malaria transmission intensity in Dubti Woreda.

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Annexes

Questionnaire-1

Title: studies on the prevalence of malaria and utilization of mosquito nets in dubti woreda

1. Patient code____________
2. Sex:-
   - Male ________
   - Female ______
3. Age ____________
4. Family size_______
5. Educational status

A. illiterate _________	E.9–12 __________
B. reading and writing _______	F. certificate ______
C. 1–4 grade _______________	G. diploma _______
D. 5–8 grade _______________	H. degree ________

6. Occupation
   A. Farmer _________
   B. Merchant _______
   C. daily laborers _______
   D. government employees _____
   E. others _________
7. Knowledge on method of transmission of malaria
   A. yes ______
   B. No ______
8. Do you have ITNs?
   A. Yes _______
   B. No ________
9. If you yes, how many?
   A. One ____ B. Two ____ C. Three and above _____

10. Habit of using mosquito net during sleeping time

A. yes ______

B. No ______

11. Based on Q.9 if your answer is yes, the frequency of using mosquito nets

A. Always ________

B. Sometimes ________

12. using of one mosquito net during sleeping time

A. single ______

B. for two _____

C. for three and above ______

13. Source of mosquito net

A. government ______

B. purchasing _______

C. both ____________

14. Habit of washing of mosquito net when it becomes dirty

A. yes _______

B. No _______

15. Presence of torn on the mosquito net

A. Yes ______

B. No _______

Questionnaires' -2

Household observation on possession, proper use of mosquito nets in Dubti Woreda, Afar region.

1. Mosquito net possession in the household

   A. owned _______

   B. not owned ______

2. Number of mosquito net owned

   A. One _______

   B. Two ______

   C. Three or more _______

3. Mosquito net gained

   A. from government ______

   B. Purchased ____________

   C. Both ________________

4. Use of mosquito net during sleeping time

   A. For one ________

   B. For two ________

   C. For three or more _______

5. Use of mosquito net for other purposes

   A. Yes _______

   B. No ________

6. In number 6 question the answer is yes, for what purpose you use other than sleeping?

   ____

   ____.

Amharic version for Questionnaire -1

መመርያ፡ይህ የፁሁፍ መጠይቅ በዱብቲ ወረዳ የወባ በሽታ ስርጭትና መንስኤዎች በተመለከተ ለማጥናት የሚረዳ ሲሆን ለትትብብርዎ ትበቅድሚያ እያመሰገንኩ በተሰጠው ክፍት ቦታ ላይ የ× ምልክት በማድረግ እንድትተባበሩ እጠይቃለሁ፡፡

1. የምዝገባ ቁጥር_________

2.ፆታ፡- ወ_______ ሴ__________

3.ዕድሜ_________________

4.የቤተሰብ ብዛት________________

5.የአንተ/አንቺየት/ት ደረጃ

ሀ. ያልተማረ ______ ሠ. ከ9 — 12 ______

ለ.ማንበብና መጻፍ የሚችል ______ ረ. ሰርተፊኬት ______

ሐ. ከ1 — 4 _______ ሰ. ዲፕሎማ ________

መ. ከ5 — 8 _______ ሽ. ዲግሪ ___________

6..የአንተ/አንቺየሥራሁኔታ

ሀ. ግብርና_________ ለ. የመንግስት ሠራተኛ_____

ሐ. ንግድ__________ መ. የቀን ሰራተኛ_________

ሠ. ሌላ_________________

7. የወባ መተላለፊያ ዘዴ

ሀ. አውቃለሁ_______ ለ. አላውቅም_____________

8. የአል.ጋ አጎበርበ ቤትዎ

ሀ. አለ ____________ ለ. የለም__________

9. አል.ጋ አጎበር በመኘ ታሰዓት

ሀ. እጠቀማለሁ___________ ለ. አልጠቀም _________

10. ከላይ በተራ ቁ.9 መልስህ(ሽ) እጠቀማለሁ ከሆነ

ሀ. ሁል ጊዜ እጠቀማለሁ __________

ለ. አልፎ አልፎ እጠቀማለሁ________

11. አንተ/አንቺ አንድ አል.ጋ አጎበር በመኘታ ሰዓት ከስንት የቤተሰብ አባለት ጋር ይጠቀማሉ?

ሀ. ለብቻ________ ለ. ለሁለት________ ሐ. ለሶስትና ከሶስት በላይ _______

12. አንተ/አንቺ የምትጠቀመውን(ሚውን) የአል.ጋ አጎበር ያገኘህው(.ያገኘሺ.ው)

ሀ. በመንግስት __________

ለ. በግዥ _______________

ሐ. በሁለቱም ___________

13. የአል.ጋ አጎበሩን በውሃ

ሀ. አጥበዋለሁ ________

ለ. አላጥበውም ________

14. አንተ/አንቺ የምትጠቀመው(ሚው) የአል ጋአጎበር ቀዳዳ

ሀ. አለው __________

ለ. የለውም ________

Amharic version for Questionnaire's -2

መመሪያ፡ ይህመጠይቅ ፡ በዱብቲ ወረዳ የአልጋ አጎበር ስርጭትና አጠቃቀምን በተመለከተ ቤት-ለቤት የሚካሄድ ጥናት ሲሆን ለትብብርዎ በቅድሚያ እያመሰገንኩ በተሰጠው ክፍትበታ ላይ የ × ምልክት በማድረግ እንዲተባበሩ እጠይቃለሁ፡፡

1. የአልጋ አጎበር በቤታችሁ ውስጥ

ሀ. አለ____________ ለ. የለም____________

2. በቤት ውስጥ ያለው የአል ጋአጎበር ብዛት

ሀ. አንድ____________ ሐ. ሶስት____________

ለ. ሁለት____________ መ. አራትናበላይ_______

3. አንተ/አንቺ የምትጠቀመው የአልጋ አጎበሩን ያገኘህው

ሀ. በመንግስት _________ ሐ. በሁለቱም_________

ለ. በግዥ____________

4. በአንድ አልጋ አጎበር ስንት የቤተሰብ አባላት ይጠቀማሉ?

ሀ. ለአንድ________________ ሐ. ሶስትና ሶስት በላይ________

ለ. ለሁለት________________

5. አልጋ ጎበር ከመኝታ አገልግሎት ውጭ ለሌላ ስራ

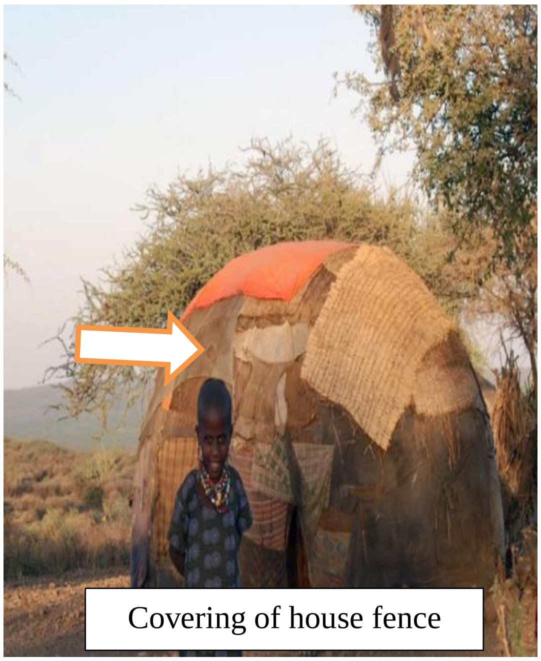
ሀ. እጠቀምበታለሁ___________ ለ. አልጠቀምበትም___________

6. ከላይ በተራ ቁጥር 5.መልስ እጠቀማለሁ ከሆነ ለምን አገልግሎት ትጠቀምበታለህ?

ግለፅ____

Using mosquito net for other purposes in Dubti Woreda

(Photograph by Andualem W, 2018)



Covering of house fence

Covering of seedling fence

Taking of vegetables to the market

Covering of biddy (chicken) house fence

Prevalence of malaria in different age group in Dubti Health Center

Age	*P. falciparum*	*P. vivax*	*Mixed*	Total	df	P. value
< 5	609 (14.8%)	73 (1.8%)	0	682 (16.5%)	1	
5 – 14	851 (20.6%)	66 (1.6%)	2 (0.04%)	919 (22.3 %)	1	0.003
≥ 15	2302 (55.8%)	215 (5.2%)	7 (0.2%)	2524 (61.2 %)	1	
Total	3762 (91.2%)	354 (8.6%)	9 (0.2%)	4125 (100%)		

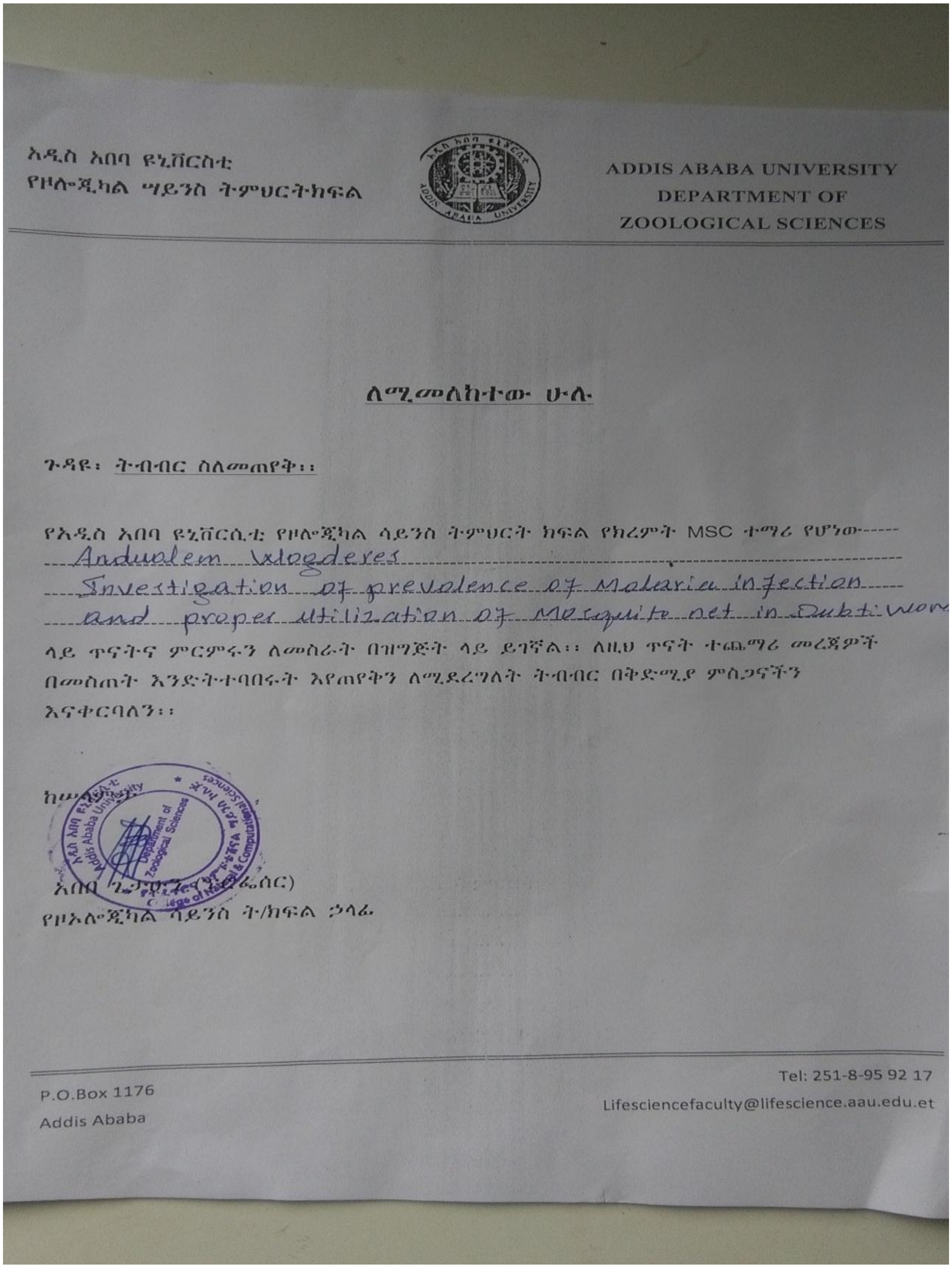
ANOVA Five year's frequency of *Plasmodium* species in Dubti Health Center

		Sum of Squares	Df	Mean Square	F	Sig.
2006	*P .f*	1451.000	1	130.0000	3	.000
	P. v	130.000	1	14.5000	3	
	Mixed	3.00	1	3.000	1	
	Total	1581.125	1	72.2500	4	
2007	*P. f*	1017.000	1	169.0000	2	.000
	P. v	35.000	1	101.0000	3	
	Mixed	2.000	1	2.000	1	
	Total	1054.000	1	527.0000	3	
2008	*P. f*	698.000	1	127.0000	3	.000
	P. v	27.000	1	29.0000	2	
	Mixed	1.000	1	1.000	3	
	Total	718.000	1	363.0000	3	
2009	*P. f*	437.000	1	30.0000	3	.000
	P. v	30.500	1	439.0000	2	
	Mixed	2.000	1	2.000	1	
	Total	469.500	1	234.5000	2	
2010	*P. f*	163.000	1	175.1400	2	
	P. v	132.000	1	308.9000	2	.000
	Mixed	1.000	1	1.000	1	
	Total	296	1	139.800	2	

Monthly Prevalence of Malaria in Dubti Health Center

Month	Total Positive	Malaria positive	*P. falciparum*	*P. vivax*	Mixed infection	df	P. value
Sept.	3391	53 (1.3%)	36 (1.1%)	17 (0.5%)	1 (0.03%)	1	
Oct.	3826	99 (2.4%)	84 (2.2%)	15 (0.4%)	2 (0.1%)	1	
Nov.	3800	107 (2.6%)	89 (2.3%)	18 (0.5%)	3 (0.1%)	1	
Dec.	4634	430 (10.4%)	404 (8.7%)	26 (0.6%)		1	
Jan.	5915	899 (21.8%)	843 (14.3%)	56 (0.9%)	2 (0.03%)	1	
Feb.	5309	970 (23.5%)	903 (17%)	67 (1.3%)	1 (0.02%)	1	0.004
March	3812	212 (5.1 %)	191 (5%)	21 (0.6%)		1	
April	4264	734 (17.8%)	705 (16.5 %)	29 (0.7%)		1	
May	3189	228 (5.5%)	196 (6.1%)	32 (1.0%)		1	
June	3219	146 (3.5%)	112 (3.5%)	34 (1.1%)		1	
July	2575	102 (2.5%)	83(3.2%)	19 (0.7%)		1	
August	3647	133 (3.2%)	113 (3.1%)	20 (0.5%)		1	
Total	47652	4125 (100%)	3762 (92.2%)	354 (8.6%)	9(0.2%)		

Appendix 8: Official letter for the concerning bodies from Addis AbabaUniversity**.**



አዲስ አበባ ዩኒቨርስቲ
የዞሎጂካል ሣይንስ ትምህርትክፍል

ADDIS ABABA UNIVERSITY
DEPARTMENT OF
ZOOLOGICAL SCIENCES

ለሚመለከተው ሁሉ

ጉዳዩ፡ ትብብር ስለመጠየቅ፡፡

የአዲስ አበባ ዩኒቨርሲቲ የዞሎጂካል ሳይንስ ትምህርት ክፍል የክረምት MSC ተማሪ የሆነው-----
Andualem Wogderes
Investigation of prevelence of Malaria infection
and proper utilization of Mosquito net in Dubti wor
ላይ ጥናትና ምርምሩን ለመስራት በዝግጅት ላይ ይገኛል፡፡ ለዚህ ጥናት ተጨማሪ መረጃዎች በመስጠት እንድትተባበሩት እየጠየቅን ለሚደረግለት ትብብር በቅድሚያ ምስጋናችን እናቀርባለን፡፡

ከሠላምታ ጋር

አበበ ጌታሁን (ፕሮፌሰር)
የዞኦሎጂካል ሳይንስ ት/ክፍል ኃላፊ

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