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KNOWLEDGE, ATTITUDE AND PRACTICE OF THE COMMUNITY
TOWARDS MALARIA PREVENTION IN NONO DISTRICT, WEST SHOA
ZONE, OROMIA REGIONAL STAT, ETHIOPIA

BY

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APPROVAL SHEET

As the thesis advisor, I certify that I have thoroughly read and evaluated this thesis entitled: ***“Knowledge, Attitude and Practice of the Community Towards Malaria Prevention in Nono District, West Shoa zone, Oromia Regional State, Ethiopia”*** in Addis Ababa University of West Ethiopia prepared under my guidance Mulugeta Birhanu. I suggest accepting it for defense and using it to satisfy the thesis requirement.

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AUTHOR'S STATEMENT

I declare that the research for this thesis is entirely original with proper citations to all sources of information used. This thesis has been turned in to partially complete the requirements of Addis Ababa University's Master of Science (MSc) program in Zoological Science. I therefore sincerely undertake that this thesis is not being submitted to any other university or location in order to receive a degree, diploma, or certificate. Short quotes from this thesis are acceptable without obtaining permission as long as the source is properly cited. Permission to reproduce this thesis in whole or in part, or to quote extensively from it, may be requested from the dean of the school of graduate studies or the head of the major department, provided that the intended use of the material advances scholarship. But in every other case, you have to get the author's consent.

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BIOGRAPHICAL SKETCH

The author Mulugeta Birhanu Kebede was born in May 1991 G.C in Oromia regional state West Shoa zone Nono district. He attended his primary education at Chando Primary School from 1998-2005 G.C. He attended his secondary education at Shenan Senior Secondary School and Preparatory. He successfully completed grade 10 national examination with excellent mark. After two years, he joined the biology department of Ambo University's College of Natural and Computational Science. In 2016 G.C., he was granted a Bachelor of Science degree in biology. He enrolled in the summer program of the School of Graduate Studies at Addis Ababa University in the Department of Zoological Science in 2018.

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LIST OF ACRONYMS AND ABBREVIATIONS

AL: artemether lumefantrine

FMOH: Federal Ministry of health

GVCR: Global vector control response

HEWs: Health Extension Workers

HHS: Households

HMIS: Health management information systems

IRS: Indoor Residual Spray

ITNs: Insecticide treated nets

LLINs: Long Lasting Insecticide Treated Nets

MDG: Millennium Development Goal

PHC: Primary Health Care

RBCs: Red blood cells

WHO: World health organization

ABSTRACT

Malaria is one of the world's most significant and widespread diseases, caused by a protozoan parasite from the Plasmodium genus. Ethiopia and other underdeveloped nations are home to the two main malaria parasite species, Plasmodium falciparum and Plasmodium vivax. Although several control measures have been implemented in Ethiopia, the inhabitants' health issue remains unresolved. The main objective of this study was to assess the community's knowledge, attitudes, and preventive behaviors related to malaria in several malaria-affected areas in the Nono District of the West Shoa zone, Oromia Region, Ethiopia. There was a cross-sectional household survey that was descriptive and based in the community. Using purposive and systematic sampling, the respondents were chosen from among the entire population of the four chosen kebeles. Out of the four malarious kebeles that were chosen for the sample size, 362 men and 22 women were methodically chosen from the Nono district's total population. Quantitative and qualitative data analysis techniques were employed in the study. Almost all the respondents (97.13%) heard and had knowledge about human health impact of malaria. The majority (90.36%) of respondents knew that malaria is caused by bite of mosquitoes. Regarding malaria symptoms, the most commonly reported were chills and shivering (98.17%) and fever (95.83%). Additionally, over 98% of respondents were aware that malaria can be transmitted between people. The majority (95.83%) of respondents believed that malaria is a preventable disease. Nearly, all (99.21%) the respondents of the study subjects thought that the use of bed net could prevent malaria, followed by drainage of stagnant water (98.69%). Greater than 95% of the respondents knew about insecticide treated nets (ITN), whereas 4.95% didn't hear about ITN in Nono district of the selected malarious kebeles. ITN was used by young people (97.13%), pregnant women (95.05%), and children under five years of age (94.01%). Regarding treatment seeking tradition, about 39.84% take traditional medicine, whereas others want health extension center (35.15%). Greater than 86% of the residents strongly agreed but 13.03% agreed that malaria was one of the major health problems. Almost all (99.21%) of the respondents thought that the use of bed nets could prevent malaria, followed by removal of standing water (98.69%), apply insecticide to the house. (96.61%), taking tablets or drugs (92.44%), using traditional medicine (84.11%), closing windows and doors (81.25%). The study revealed a significant gap between the respondents' knowledge of preventive measures and their actual practice of malaria prevention and control methods. Therefore, it is crucial that health education initiatives be implemented, and greater attention and priority be given to minimizing this gap in the community's knowledge, attitudes, and prevention practices regarding malaria.

Keywords/phrases: Anopheles; Breeding site; Malaria infection, Stagnant water; Bed net

1. INTRODUCTION

1.1 Background

Malaria is primarily a vectorborne disease caused by the protozoan genus *Plasmodium*. According to Orasmo and Fonseca (2024), *Plasmodium* is a unicellular eukaryotic parasite. Five species are known to infect humans with malaria: *P. falciparum*, *P. malariae*, *P. ovale*, *P. knowlesi* and *P. vivax* (Bugssa *et al.*, 2020). The five human malaria species are not equally distributed throughout the world's malaria-affected regions, and each zoo-geographical location has a different relative relevance for each species within and between areas (WHO, 2016; 2017). The most prevalent species, *P. falciparum*, is found mostly throughout Africa, especially in regions south of the Sahara. *P. vivax* predominates in the subtropics and coexists with *P. falciparum* in tropical Asia, the tropical Americas, and the Horn of Africa (Nicholas *et al.*, 2014). *P. ovale* is found in Africa and sporadically in Southeast Asia and the western Pacific. *P. malariae* has a similar geographical distribution to *P. falciparum*, but its incidence is lower and its distribution is patchy (WHO, 2015). Malaria parasites are transmitted by female mosquitoes belonging to the genus *Anopheles*.

There is significant variation in the risk of catching malaria between nations and even within a single country (Nicholas *et al.*, 2014). The late 19th century saw the greatest spread of malaria in the world, and since then, the area where malaria is spread has been decreasing. Southeast Asia has seen a rise in the number of reported cases of zoonotic *Plasmodium* infections during the past ten years, primarily *P. knowlesi* especially in Malaysia (Bugssa *et al.*, 2020). Several macaque species present in Southeast Asian woods serve as the species' natural reservoirs (Nicholas *et al.*, 2014). The primary vectors are members of the *Anopheles leucosphyrus* group, which is also connected to forests. The majority of human infections with these parasites occur from bites from infected *Anopheles* mosquitoes, sometimes known as "malaria vectors. Research has indicated that malaria primarily affects tropical and subtropical locations worldwide (Simon, 2016). Malaria is endemic in 106 developing countries, including those in Africa, the Amazon, Central and Southern America, central, south, and southeast Asia, and the Pacific as stated by Simon (2016). In low malaria transmission areas, a package for supplementing social capital and sustaining community participation for elimination will be essential, like 'sentinel sites' for qualitative monitoring of evolving local socio-cultural, behavioral, and practical issues that

impact malaria prevention and treatment; mobilizing social networks; intersectoral collaboration; integration of malaria interventions with activities addressing other community health and disease priorities; and targeted implementation of locally appropriate, multi-level media campaigns that sustain motivation for community participation in malaria elimination (Atkinson *et al.*, 2010).

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female *Anopheles* mosquitoes. It is preventable and curable. There are 5 parasite species that cause malaria in humans, and 2 of these species – *Plasmodium falciparum* and *Plasmodium vivax* – pose the greatest threat (WHO, 2022).

In 2022, nearly half of the world's population was at risk of malaria. While sub-Saharan Africa carries a disproportionately high share of the global malaria burden, the WHO regions of South-East Asia, Eastern Mediterranean, Western Pacific, and the Americas also report significant numbers of cases and deaths. There were an estimated 249 million cases of malaria in 2022, and the estimated number of malaria deaths stood at 608 000. In 2022, the African Region was home to 94% and 95% of malaria cases and deaths, respectively. Children under 5 years of age are the most vulnerable group affected by malaria; in 2022, they accounted for nearly 80% of all malaria deaths in the African Region(WHO, 2022).

1.2 Statement of the problem

Among the nations that have put the updated malaria prevention measures into practice is Ethiopia. Malaria still causes considerable morbidities and fatalities in Ethiopia's endemic areas, despite enormous efforts to put these techniques into practice. The nation's socioeconomic development and health are severely harmed by this disease. Because health extension workers (HEWs) are the ones who execute malaria preventive and control measures at the grassroots level, this study aimed to investigate factors that contribute to this problem at the household level as well. Malaria prevention is less in Nono district compared to other districts found in West Shoa Zone. Consequently, many people living in this area suffer from the problem. Malaria prevalence is alarmingly high and strongly necessitates the initiation of this study. As a result, the main purposes of this research are to identify the knowledge, attitude and prevention practice of community as well as malaria prevalence in Nono district in some selected malarious kebeles.

The problem addressed in this thesis is the lack of comprehensive understanding and evaluation of the community's knowledge, attitude, and practice towards malaria prevention in Nono district, West Shoa Zone, Oromia Regional State, Ethiopia. Despite the considerable efforts in malaria prevention, there is a need to assess the level of knowledge among the community regarding the disease, their attitudes towards preventive measures, and the actual practices implemented. This assessment will provide valuable insights for policymakers and healthcare professionals to design targeted interventions and improve overall malaria prevention strategies in the study area.

1.3 Objective of the research

1.3.1 General objectives

- ❖ The overall goal of the study was to assess knowledge, attitude and practice of the community towards malaria prevention in Nono district

1.3.2 Specific objectives

The specific objectives of this study are:

- To assess the causes of malaria prevalence at house hold level in study area
- To assess the knowledge, attitudes and perceptions of households in the study area about the prevention and control methods of malaria
- To examine practices of the people in the prevention and control of malaria

1.4 Research question

The study was focused on the ensuing leading question.

1. What are the causes of malaria prevalence at the household level ?
2. How do households in the study area perceive and understand malaria ?
3. How do households in the study area practice malaria prevention and control methods ?

1.5 Scope of the study

The study was expected to generate data on knowledge; attitude and prevention practice of community as well as malaria prevalence in Nono district. However, the study was delimited to some kebeles of Nono district found in West Shoa zone of Oromia regional state, due to limited availability of resource and time.

1.6 Significance of the study

The findings from this study will offer valuable insights into the community's knowledge, attitudes, and practices related to malaria prevention. The results can inform the development of targeted interventions and strategies to improve malaria control efforts in Nono District and similar settings in Ethiopia.

1.6 Definition of key terms

Attitude: Refers to the beliefs, perceptions, feelings, and predispositions that individuals or communities hold toward malaria.

Control: To bring the illness burden down to a point where it poses no longer a serious threat to public health.

Detection: One of the activities of surveillance operations, involving a search for malaria cases in a community.

Indigenous: A case contracted locally with no evidence of importation and no direct link to transmission from an imported case.

Knowledge: Information and skills acquired through experience or education.

Malaria elimination: Interruption of local transmission (reduction to zero incidences of indigenous cases) of a specified malaria parasite species in a defined geographical area as a result of deliberate activities.

Malaria eradication: The purposeful, long-term worldwide eradication of all human malaria infections.

Malaria: The occurrence of a malaria infection in an individual, confirmed by diagnostic testing for the existence of malaria parasites in the blood.

Plasmodium: A protozoan that causes malaria disease.

Population at risk: Population living in a geographical area where locally acquired malaria cases have occurred in the past three years.

Prevalence: The wide spreading of malaria disease.

Surveillance: It is recognized as an intervention for malaria eradication in Malaria Eradication Programme.

Transmission: The mechanism of transmitting disease of malaria from infected subject to apparently healthy individual.

2. LITERATURE REVIEW

2.1 An overview of malaria

Malaria is potentially fatal infection which is caused by *Plasmodium* parasite . Malaria is the most lethal disease in the world and malaria mostly affects Africa (Adhanom, 2006; Abebe Alemu *et al.*, 2012). In Ethiopia, where it has long been the primary cause of sickness and mortality, malaria remains a serious problem (Adhanom, 2006). As stated in data from the Ethiopian Federal Ministry of Health, approximately 75% of Ethiopia's land area is prone to malaria, and around 68% of the population lives in regions where malaria is a concern (Adhanom, 2006). This equates to over 50 million people at risk of contracting the disease (Lesaffre and Spiessens, 2001; Abebe Alemu *et al.*, 2012), with an estimated 4-5 million Ethiopians affected by malaria annually (FMH, 2004). Altitude and precipitation levels primarily influence the spread of malaria in Ethiopia, with a latency period ranging from several weeks before the rainy season to over a month after its conclusion (Tulu, 1993; Deressa, 2003). Malaria epidemics are relatively common, particularly in the highland and highland fringe areas of the country, typically at elevations between 1,000-2,000 meters above sea level (Tulu, 1993; Adhanom, 2006; FMH, 2006; Zhou, 2004; WHO, 2006). The two main harvesting season from April to May and September to December—are when malaria transmission peaks twice a year. Ethiopia's subsistence economy and the country as a whole will suffer greatly as a result. Every five to eight years, there are major epidemics, with focused epidemics being the most common type. One of the most important methods of treating malaria is early diagnosis. Clinical diagnosis is frequently utilized in places without access to laboratory facilities (WHO, 2000; FMH, 2004).

2. 2 Biology of malaria

Malaria is caused by the *Plasmodium* protozoan parasite, which is transmitted by female Anopheles mosquitoes, primarily during the hours between sunset and sunrise (Bugssa *et al.*, 2020). The *Plasmodium* species that infect humans include *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *p.knowlesi*. While there is currently no evidence of direct human-to-human transmission, the non-human malaria parasite *P. knowlesi* has been increasingly reported to infect humans in Southeast Asia in recent years (WHO, 2015). Of the human malaria parasite species, *P. falciparum* and *P. vivax* pose the greatest threat, with *P. falciparum* being the most

dangerous and responsible for the majority of malaria-related deaths. Approximately half of all malaria cases outside of sub-Saharan Africa are caused by *P. vivax*, which is more common in countries that are good candidates for elimination; in countries where there are fewer than 5000 cases annually, the parasite is responsible for over 70% of all cases of malaria (WHO, 2016). *P. vivax* can remain dormant in the liver for several months or even years after inoculation, and it can lead to recurrent episodes of malaria infection. Just 30 to 40 of the approximately 515 *Anopheles* species are thought to be significant malaria vectors (Maia et al., 2018). Within a single geographic area, several species can coexist, each with its own biting and resting habits as well as a preferred human or animal host. As a result, the effectiveness of a species' ability to spread and its sensitivity to current or future anti-mosquito therapies varies greatly between species (WHO, 2017).

2.2.1 Life cycle of malaria

The human host is bitten by an adult female *Anopheles* mosquito carrying the *Plasmodium* parasite, which feeds on blood (Figure 1; Iriemenam et al., 2011). As it consumes this blood, malaria sporozoites—parasites—are released into the host's bloodstream (a human being). This bite is contagious. After entering the bloodstream of a human, the parasites swiftly travel to the liver cells, where they proliferate and grow (schizogony). According to Iriemenam et al. (2011), the infected liver cells rupture and release a large number of merozoites into the bloodstream, which invade red blood cells (RBCs). 9–14 days pass during this phase within the RBCs the parasites develop from “rings” into blood schizonts. The schizonts then rupture the RBCs releasing numerous merozoites which invade new RBCs. When the infected red blood cells rupture, this process initiates the chills and fever which are characteristic of malaria. Indeed, the peaks of fever experienced during malaria coincide with the release into blood circulation of malaria parasites (merozoites) from ruptured RBCs (Iriemenam *et al.*, 2011). The period between the infective bite and the onset of symptoms (fever chills) is called the incubation period of malaria. As we mentioned earlier, the incubation period is usually 7-14 days but may be shorter as in *P. falciparum* or longer in the instance of *P. vivax* and *P. malaria* (Wikieducator, 2008).

by a female *Anopheles* mosquito that bites an infected individual. Inside the gut of the mosquito, the parasite (gametocytes) undergoes sexual reproduction into the sporozoite forms which then migrate into salivary glands of the mosquito. When this mosquito bites again, the parasites (protozoans) travel through the blood vessel into the liver where they multiply rapidly (through asexual reproduction) producing thousands of merozoites (Worrall *et al.*, 2005). These merozoites infect mostly new blood cells and reproduce inside them and burst the cells. Other merozoites develop into gametocytes which again be spread to other people. Blood transfusions can potentially spread malaria parasites, particularly in regions where the disease is endemic. There is evidence of mother-to-fetal transfer (Worrall *et al.*, 2005). *Plasmodium* parasites, mosquitoes, human hosts, and environmental factors all influence the degree of malaria infection and illness transmission (WHO, 2014). In the area where the vector's lifespan is longer, there is more intense of transmission. That's why, according to Yeka *et al.* (2012), 90 percent of malaria infections occurred in underdeveloped nations in Africa, particularly in the Sub-Saharan Africa. This is due in part to the lengthy life cycle, biting behavior, and widespread distribution of *Anopheles Gambiae* throughout Africa (Freedman, 2008). Another factor influencing the spread of malaria is the climate. Temperature, humidity, and rainfall patterns all have an impact on mosquito population and survival. A malaria epidemic can happen if certain factors, such as the environment, suddenly promote the disease's spread and if people travel to an area where the disease is highly contagious. It can also happen when individuals with weakened immune systems travel to areas where the disease is highly contagious, such as refugees (Freedman, 2008). The poorest nations have higher rates of malaria infections, especially in emerging nations (Banerji, 2002; Sachs and Malaney, 2002; Sharma *et al.*, 2015). WHO adds, however, that poverty is not the reason for the high prevalence of malaria in developing nations (Sachs and Malaney, 2002; Yeka *et al.*, 2012). The malaria infection is partially caused by these countries' physical location. Malaria is a disease that is unique to certain regions. This is because malaria mosquito vectors, which control the distribution of disease intensity, are supported by the ecological circumstances of these countries' localities (Sachs and Malaney, 2002; Worrall *et al.*, 2005, Hay *et al.*, 2010). In sub-Saharan undeveloped nations, this parasite causes mortality from malaria (Muller *et al.*, 2009; Yeka *et al.*, 2012). When meteorological circumstances are right, man-made environmental modifications including irrigation systems, water reservoirs, dams, and afforestation boost mosquito breeding grounds, which in turn starts the epidemic. An essential

determinant in the zone of moderate to high malaria transmission is the immunity of the human host, particularly in adults (WHO, 2014). This immunity, which develops over years of exposure, provides a partial immunity against malaria but does not ensure total protection. On the other hand, it lessens the likelihood that these people may contract certain diseases, like cerebral malaria (Reiter, 2000; Freedman, 2008). One of the main causes of malaria deaths is that young children in impoverished nations, particularly in Africa, do not yet have a fully developed immune system (Freedman, 2008). This is because immunity is specific to the group that is most vulnerable. These at-risk populations include children who have not yet fully developed immune systems; pregnant women who are HIV-positive and have a higher chance of getting malaria, also the same to international travelers who are not immune to malaria; and immigrants (Freedman, 2008; Yeka et al., 2012).

2.2.3 Signs and symptoms of malaria

Malaria usually manifests its symptoms 8–25 days after infection. However, people who have taken anti-malarial medicine as a preventative measure may experience symptoms later. All malaria species share initial symptoms that are comparable to flu-like symptoms and can be mistaken for other illnesses such viral infections and gastroenteritis (Asrat, 2017). According to Beare *et al.*, (2006), possible symptoms include hemolytic anemia, jaundice, a headache, shaking, pain in the joints, vomiting, hemoglobin in the urine, retinal impairment, fever, and convulsions. *P. ovale* infections cause paroxysm, a cyclical episode of abrupt coldness, shivering, fever, and sweating that happens every two days, while *P. malariae* infections cause paroxysm every three days. According to Ferrer (2009), a *P. falciparum* infection can result in a less severe, nearly constant fever or recurrent fever every 36–48 hours. Rarely, *P. vivax* and *P. ovale* cause major difficulties, crippling deteriorations, and even death from malaria. *P. falciparum* is responsible for almost all severe forms and deaths from the disease. Brain, pulmonary edema, severe anemia, abrupt renal failure and bleeding are the main side effects of severe malaria. Based on Bartoloni and Zammarchi (2012), acidosis and hypoglycemia are the most prevalent metabolic problems that occur. Malaria symptoms can return after varied intervals of time without symptoms. Recurrence can be categorized as recrudescence, relapse, or re-infection depending on the underlying reason (WHO, 2010). Reappearance can be caused by any of the following: a) therapeutic failure from treatment non-adherence, parasite drug resistance, or subpar medication; b) *hypnozoite* reactivation; and c) exposure to fresh infection by

mosquito vector contact. Recurrence of symptoms occurs when they do not go away for a while. It is brought on by parasites that survive in the blood stream as a result of insufficient or inefficient medical care. This is more common when *P. falciparum* or *P. vivax* causes malaria, and less common when *P. malariae* causes malaria (White, 2011). Relapse in malaria refers to the reappearance of parasites in the blood and the return of clinical symptoms. This occurs when merozoites from dormant liver-stage parasites called hypnozoites reactivate and invade red blood cells. Relapse can happen 180-420 days after treatment for the temperate *P. vivax* strain, and 21-140 days after treatment for the tropical *P. falciparum* strain. Treatment failure is the primary cause.

Malaria infection involves two distinct stages: the exoerythrocytic phase and the erythrocytic phase. During the exoerythrocytic phase, sporozoites from an infected mosquito's saliva enter the human bloodstream and travel to the liver, where they infect liver cells (hepatocytes). Here, the parasites undergo asexual reproduction without causing any symptoms, for a period of 8 to 30 days (Bledsoe, 2005). In some cases, the parasites can enter a latent phase in the liver before differentiating and producing hundreds of merozoites. These merozoites then break free from the liver cells and enter the bloodstream, marking the start of the erythrocytic stage. In the erythrocytic phase, the merozoites infect red blood cells (erythrocytes). The majority of the parasite's life cycle in humans takes place within the liver and blood cells, shielding it from immune system detection (Bledsoe, 2005). However, the spleen does eliminate infected and circulating blood cells. To avoid this, the *P. falciparum* parasite adheres to the surface of infected blood cells, causing them to stick to the walls of small blood vessels. This sequestration of red blood cells can allow the parasite to cross the blood-brain barrier, leading to cerebral malaria, or result in symptoms similar to placental malaria due to microvasculature blockages (Tilley *et al.*, 2011; Renia *et al.*, 2012).

2.3 Global malaria burden

Malaria is an ancient illness that most likely started in Africa and spread with people as they migrated to south-east Asia, India, and the Mediterranean coast (Bynum, 2008). Malaria, which is Latin for "bad air," was once widespread in the marshy regions surrounding Rome. This region was also known as Roman fever (Bynum, 2008; Dyann and Pedro, 2017). *Plasmodium* protozoa are the cause of malaria and are spread by the bite of female *Anopheles* mosquitoes. Malaria is

primarily found in tropical and subtropical regions, especially the humid areas of South and Central America, Asia, and Africa. The disease is caused by five species of the Plasmodium parasite: *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*, and the zoonotic *P. knowlesi* (Dyann and Pedro, 2017). The complex interactions between the parasite, host, and vector are the main factors that contribute to the disease's complexity and epidemiology. Malaria epidemiology can be classified as either stable (stably endemic) or unstable (unstably endemic or epidemic-prone). Stable malaria refers to areas with a detectable incidence of natural transmission for at least six months over several years (WHO, 2016; Dyann and Pedro, 2017). In contrast, unstably endemic areas experience only seasonal transmission (Ashenafi, 2008; WHO, 2016). Regions with persistent, high-level endemicity, known as holoendemic zones, typically have populations with high immunity and better tolerance to the infection, often with minimal or no symptoms. The topography and climate of a country can influence malaria transmission, which is often highest during the rainy season. Epidemic malaria can occur in areas with low to moderate endemicity or in regions previously free of malaria, affecting non-immune populations. These outbreaks are usually triggered by changes in human behavior or environmental factors (Woyessa *et al.*, 2012).

The major pools for the malaria parasite are humans, and contact between infected people and anopheline mosquitoes, as well as vice versa, is necessary for continuous transmission of the malaria parasite (Miller *et al.*, 2002; Dyann and Pedro, 2017). The ability of mosquitoes to support sporogony is simply one element that affects their capability to transmit malaria; other aspects include eating habits, longevity, and density (Breman *et al.*, 2004). The population and behavior of mosquitoes can be influenced by ecological and climatic factors (Fernando, 2020). Human infection pools act as parasite reservoirs, enhancing the survival of parasites that proliferate near human habitations (WHO, 2006; Fernando, 2020). Pregnant women and children under five years old, as well as immunocompromised individuals, are typically the only groups at risk for serious illness (Snow *et al.*, 1997). In contrast to places with high transmission intensities, populations vulnerable to low to moderate intensities of communication showed the highest illness risk (Snow *et al.*, 1997).

The impoverished and the poorest populations worldwide are disproportionately affected by malaria (Worrall *et al.*, 2005; Teklehaimanot and Mejjia, 2008). The connection between poverty and malaria has been hotly contested. It is clear that individuals with lower socioeconomic status

are more susceptible to malaria infection. This is because they often lack access to preventive measures, adequate housing, air conditioning, and appropriate diagnosis and treatment. Malaria can significantly impact productivity and absenteeism from work, contributing to the "poverty trap" experienced by many in rural Africa. The disease often strikes during harvest seasons, and even a few lost workdays can have a substantial negative effect on output. While the burden of malaria disproportionately affects the poor, some researchers and policymakers argue that malaria is primarily a disease of the tropics, with its determinants being primarily ecological and climatic factors (Breman *et al.*, 2004; Worrall *et al.*, 2005; Teklehaimanot and Meja, 2008; Meara *et al.*, 2010). However, as the global distribution of malaria has been shrinking, the disease burden and distribution increasingly align with global socioeconomic indicators. Women, small children, and those residing in less accessible places are the most commonly afflicted groups by malaria, which is most prevalent in the least developed countries (Cibulskis *et al.*, 2016). About 80% of the world's malaria cases are in 15 sub-Saharan African and Indian nations, according to the 2018 WHO world malaria report (WHO, 2018). Approximately 45% of malaria cases worldwide are caused by four sub-Saharan African nations: Nigeria, the DR Congo, Uganda, and Mozambique (WHO, 2023).

2.4 Malaria situation and burden in Ethiopia

2.4 1Malaria situation in Ethiopia

The primary determinants of malaria transmission in Ethiopias are altitude and climate, which result in a highly cyclical and predominantly unsettled pattern. Malaria transmission peaks from September through December, with the least activity occurring from April to May. Ethiopia has four main eco-epidemiological strata associated with the spread of malaria: Highland areas above 2,500 meters, Highland fringe areas between 1,500 and 2,500 meters (affected by frequent epidemics), Lowland areas below 1,500 meters (seasonal transmission pattern) and Stable malaria areas (year-round transmission, restricted to the western lowlands and river basins). The two most common malaria parasites in Ethiopia are *Plasmodium falciparum* and *Plasmodium vivax*, which are estimated to account for 60% and 40% of all malaria cases, respectively (Covell, 1957; PMI, 2015; Federal Ministry of Health, 2006). Less than 1% of cases are caused by *Plasmodium malariae*, while *Plasmodium ovale* is extremely uncommon (Jima *et al.*, 2007; Shargie, 2008; Jima *et al.*, 2012). *Anopheles arabiensis* is Ethiopia's main malaria vector, with

Anopheles pharoensis, *Anopheles funestus*, and *Anopheles nili* serving as secondary vectors (Federal Ministry of Health, 2006). Since little malaria transmission is apparent at altitudes above 2,000 meters, most malaria interventions, including insecticide-treated nets, are targeted to areas below 2,000 meters (Federal Ministry of Health, 2012).

2.4.2 Malaria burden in Ethiopia

Malaria represents a significant public health issue in Ethiopia. Malaria cases spread more broadly during normal monsoon years than during drought years, owing to a more favourable environment for mosquito breeding. The unpredictable and seasonal transmission pattern of malaria is influenced by altitude and rainfall. In Ethiopia, the majority of regions have peak malaria transmission from September to December, following the primary wet season (June to August), and the second minor transmission occurs from April to June, following a brief rainy season (February to March) [Berhe *et al*, 2019]. It is estimated that 75% of Ethiopia's landmass is malarial, and 68% of its population is at risk of getting the illness. The most severe form of malaria is caused by *Plasmodium falciparum*, responsible for 60–70% of malaria cases in the country (Federal Ministry of Health, 2016). While *Anopheles pharoensis* is widely distributed throughout Ethiopia and has high levels of pesticide resistance, its contribution to malaria transmission remains uncertain. In much of Ethiopia, malaria transmission peaks between September and December, following the primary rainy season that lasts from June to August (PMI, 2015).

A brief wet season from February to March is followed by a second "minor" malaria transmission period in some places, which runs from April to June. The two months with the least amount of malaria transmission are usually January and July (PMI, 2015). In Ethiopia, the epidemiological pattern for the spread of malaria is often erratic and seasonal. Due to variations in rainfall patterns and altitude, the transmission levels vary from location to location. However, altitude has a significant impact on temperature, which determines the distribution of malaria (MIS, 2007; MIS, 2011). The regions with the highest risk of malaria in Ethiopia are the western lowlands of Oromia, Amhara, Tigray, and nearly the entire Gambella and Benishangul Gumuz areas. According to a study by Aschalew and Tadesse (2016), small-scale surveys have reported varying malaria parasite prevalence rates across different regions: Gambella: 10.4–13.5%, Tigray: 7.6–14.1%, Amhara: 4.6%, Oromia: 0.9% and Southern Nations, Nationalities,

and Peoples' Region (SNNPR): 5.4%. These prevalence rates are across all age categories, indicating the widespread nature of the malaria burden in these regions. The western lowlands, which encompass parts of Oromia, Amhara, Tigray, Gambella, and Benishangul Gumuz, clearly emerge as the areas with the highest risk of malaria transmission in Ethiopia. The small-scale studies provide valuable insights into the regional variations in malaria parasite prevalence, highlighting the need for targeted interventions and resource allocation to address this public health challenge effectively.

2.5 Surveillance of malaria in Ethiopia

Malaria surveillance in elimination settings consists of a series of actions that should enable (i) the identification of all malaria infections; (ii) the prevention of further transmission from each case through swift, drastic treatment and vector control; and (iii) the identification, investigation, classification, and management of all transmission foci with suitable measures to stop transmission as soon as possible (WHO, 2017; Tsegaye and Bern, 2018; Bugssa *et al.*, 2020). Ethiopia's Health Extension System offers a singular chance for nationwide continuous monitoring since every kebele, or lowest administrative unit, has a health post manned by Health Extension Workers (HEWs) who do routine RDT tests for malaria. According to Ayele *et al.* (2013), healthcare facilities can offer longitudinal data on a considerable patient population at varied spatial and temporal intervals, provided that the documentation is correct. To this end, the Ethiopian recording system is being improved with the introduction of health management information systems (HMIS). Effective reporting and planning are made easier by HMIS for malaria control and prevention initiatives (Joshua *et al.*, 2014; Bugssa *et al.*, 2020). Ethiopia has ended extraordinary strides fight against malaria throughout the previous few decades (Global Fund, 2009), despite challenges posed by drug resistance, insecticide resistance, and climate change (Tsegaye and Bern, 2018). The feasibility of eliminating malaria in Ethiopia using the WHO assessment tools/recommendation for elimination of malaria (WHO, 2017).

2.6 Recent research advances in malaria control and prevention

The global burden of malaria was significantly reduced between 2000 and 2010, thanks to a major increase in financial resources for the disease's control; however, after that, funding for malaria has essentially stagnated (WHO, 2021). Furthermore, the funding gap between what has been invested and what is needed has continued to widen in recent years, primarily due to

population growth and the need to switch to more expensive tools (US\$1.3 billion in 2017 to US\$2.3 billion in 2018 and US\$2.6 billion in 2019) (WHO, 2020). Between 2000 and 2015, the infection prevalence of *P. falciparum* in endemic Africa was halved and the incidence of clinical disease fell by 40% (Deribew *et al.*, 2010). In Africa, malaria prevention treatments prevented an estimated 663 (credible range (CI) 542–753) million clinical cases; ITNs accounted for the majority of these cases, averting 68% of the cases. An estimated 13% (11–16%) of the IRS was contributed; in cases where intervention coverage was high, the proportionate contribution was higher (WHO, 2017). Only with adequate people resources, supportive infrastructure, and an operational health system can vector control be achieved in a sustainable and effective manner. In order to assess current capacity, define the necessary capacity to carry out proposed activities, find opportunities for improved efficiency in vector control delivery, and direct resource mobilization to implement the national strategic plan, national programs should spearhead a needs assessment for vector control across the relevant sectors (WHO, 2020). Vector control strategies may be able to lessen the burden of several diseases and their transmission in specific environments. Examples include the deployment of ITNs against malaria and lymphatic filariasis (in settings where anopheles mosquitoes are the principal vector), indoor residual spraying (IRS) against malaria and leishmaniasis in India, and larval control for malaria and dengue vectors in cities with particular vector habitats (World Health Organization, 2017). Global vector control response (GVCR) deployment is clearly made possible by the recently discovered *Anopheles stephensi* invasion in the Horn of Africa, which calls for integrated surveillance and control of this vector in addition to *aedes* (WHO, 2021). The GVCR's ultimate purpose is to reduce the threat and burden of vector-borne diseases by implementing sustainable, locally appropriate, and effective vector control in complete accordance with the sustainable development goal of ending malaria outbreaks by 2030 (WHO, 2021).

Pyrethroids, the greatest widely used compound for indoor residual spraying and solitary insecticide class utilized for insecticide treated nets, are crucial to modern ways of controlling malaria vectors. Mosquitoes are more likely to become resistant when a single class of pesticides is used extensively, which might quickly result in a serious public health issue (WHO, 2010). In addition to resistance, other issues with bed nets as a malaria prevention strategy include coverage, correct use, and replacing worn-out or torn nets. In addition, taking into account the potential changes in the local malaria epidemiology (the study of disease transmission and

control) highlights the necessity of assessing the appropriate use and efficacy of this control strategy in order to guarantee the long-term advantages of it (Deribew *et al.*, 2010). Despite the fact that research indicates malaria mosquitoes are resistant to typical insecticides used to treat bed nets (Banteyerga, 2011). ITNs continue to be the primary method of controlling malaria. Nonetheless, further investigation is required to examine alternative inventive methods and instruments for managing malaria in Ethiopia. One of the primary obstacles to controlling and preventing malaria in Ethiopia is low community perception and awareness, which calls for successful behavioral modification initiatives (Deribew *et al.*, 2012). Studies on ITNs undertaken in diverse contexts have produced varying conclusions about how well they work to lower the risk of malaria owing to a variety of circumstances. For instance, a study conducted in the plateaus of Bangladesh revealed that homes with less than three bed nets are twice as likely to have malaria as those with three or more bed nets (Haque *et al.*, 2009).

2.7 Diagnosis and treatment

2.7.1 Diagnosis

The primary goal of managing and controlling malaria is early and accurate diagnosis (Abreha *et al.*, 2014). While microscopy, fast diagnostic tests, and polymerase chain reaction (a highly sensitive but overly complex diagnostic method) are used in the diagnosis of malaria, most diagnostic methods in Sub-Saharan Africa are based on clinical findings and parasitological detection of parasites in both thick and thin blood films. An history of fever within the previous 48hrs is the diagnostic strategy used in clinical diagnosis since fever is the primary sign of malaria. Even though a clinical diagnosis is the least expensive, it is not exact since the clinical presentations utilized for confirmation are comparable to those of other febrile disorders and lack specificity. Accordingly, in order to determine which patients should receive treatment for each species of *Plasmodium*, confirming diagnoses are necessary (WHO, 2010; WHO, 2016).

In places where malaria is endemic, it is crucial to have high diagnostic sensitivity and specificity for the most vulnerable populations, including children, expectant mothers, and non-immune persons, as malaria can be lethal very quickly. High specificity also helps to prevent unneeded anti-malaria therapies (WHO, 2011). The microscopic mode of investigation is time-consuming and interprets very poorly, especially in cases of low-density parasitaemia. Furthermore, it is occasionally possible for the parasites in patients with *Plasmodium falciparum*

malaria to get sequestered, in which case it becomes impossible to identify sequestered *Plasmodium falciparum* parasites (Eshetu, 2016). The gold standard for diagnosing malaria in much of the globe remains the identification of *Plasmodium* species in Giemsa stain through microscopic thick and thin blood film exams, notwithstanding the availability and usage of fast diagnostic and molecular techniques (Eshetu, 2016). This method is also used in the evaluation of the level of parasitaemia (Edenshaw *et al.*, 2008; Ayele, 2013). However, microscopic confirmation of probable malaria is laborious and necessitates the use of skilled workers, electricity, and microscopes. The use of RDTs is very valuable for a reliable diagnosis of malaria for treatment decisions and for directing the use of various anti-malarial medications in remote malarial locations where microscopy is not accessible. RDTs are easy to use and efficient for quickly diagnosing malaria, which aids in the implementation of control measures in various contexts (Kamel *et al.*, 2016). RDTs sometimes called “dipsticks” used to detect *plasmodium* parasite specific circulating antigens in a finger pierce blood. Because circulating parasite antigens can linger in the bloodstream for a while even after parasite removal, using RDTs in some situations may result in false positive results. For instance, Pf HRP-2 based kits may show positive findings for *plasmodium* even up to three weeks following treatment and parasite

2.7.2 Treatment

The treatment of malaria typically involves a combination of medications, including anti-malarial drugs, fever-controlling medications, anti-seizure medications (when necessary), as well as fluids and electrolytes. The specific drugs used depend on the severity of the illness and the potential for chloroquine resistance. Some of the common medications used to treat malaria in Ethiopia include: Chloroquine, Quinine, Hydroxychloroquine (Coartem), Atovaquone (Meprom), Proguanil (generic), Mefloquine, Clindamycin (Cleocin), and Doxycycline. The choice of these medications is guided by factors such as the type of malaria parasite, the patient's response to treatment, and the risk of drug resistance in the local area (Watts and Edstein, 2012). Prompt and adequate chemotherapy is the cornerstone of malaria treatment efforts, helping to restrict the disease's spread (Mboera *et al.*, 2013). Treatment should adhere to nationally established protocols given the prevalence of medication resistance (WHO, 2000). Chloroquine was effective in treating nearly all instances of malaria in prior years. However, recent research has shown that *P. falciparum* resistant to chloroquine is becoming more common in various nations (Chinappi *et*

al., 2010). Furthermore, variants of *Plasmodium falciparum* resistant to methamine and sulfadoxine-pyrimethamine appeared prior to 2004. As a result, after the year indicated above, artemetherlumefantrine replaced sulfadoxine-pyrimethamine as the initial course of therapy for patients with *Plasmodium falciparum* malaria (WHO, 2010). In the first instance of care for *Plasmodium falciparum* malaria, ACTs have been implemented in the majority of countries. WHO advises treating simple cases of *Plasmodium falciparum* with ACT (WHO, 2010). This medication should be used to treat *P. vivax* malaria in regions where chloroquine is still effective. An suitable ACT should be used to treat *P. vivax* malaria in cases where resistance to chloroquine has been shown. However, both ACT and chloroquine should be used in conjunction with a 14-day course of primaquine to avoid relapses in *P. vivax* and *P. ovale* (except from pregnant women and babies under 6 months of age).

P. falciparum patients should get a single dose of primaquine (0.25 mg/kg) on the first day of their ACT treatment if they live in locations targeted for malaria elimination and where there is a risk of artemisinin resistance. Research suggested that combination medication therapy could effectively treat patients and delay the development of drug resistance (Okell *et al.*, 2014). Adults and children with severe malaria, including newborns, pregnant women in all trimesters, and nursing women, should get full doses of efficient antimalarial treatment as soon as possible. After this, a complete three days of oral, effective ACT should be administered. Two classes of medicine are available for parenteral treatment of severe malaria, artemisinin derivatives (artesunate or artemether) and the cinchona alkaloids (quinine and quinidine). The first line of treatment for patients with simple *P. vivax* and *P. falciparum* infections in Ethiopia is currently recommended to be artemetherlumefantrine (AL) and chloroquine, respectively. AL is used to treat mixed *Plasmodium falciparum* infections (Okell, 2014; Molla, 2016). However, a study carried out in southern Ethiopia revealed evidence of *P. vivax* clinical treatment failure following chloroquine, and this is most likely because of resistance to chloroquine (Chinappi *et al.*, 2010).

2.8 Drugs and resistance

The capability of a parasite to persist and proliferate in spite of the administration and absorption of a medicine at dosages that are comparable to or greater than those that are typically advised, provided that the subject's tolerance limits are respected, is known as drug resistance (WHO, 2001). The delivery of an efficient antimalarial regimen that eliminates all parasites from the

blood, relieves acute disease symptoms, and prevents recurrent infection is necessary for the successful treatment of malaria (Price and Nosten, 2001). The most lethal species of Plasmodium in Africa, *P. falciparum*, has become resistant to affordable, safe anti-malarial drugs including sulfadoxinepyrimethamine (SP) and chloroquine (Witkowski *et al.*, 2009). The World Health Organization advised using combination anti-malarial medicines based on artemisinin due to the emergence of resistance to SP and chloroquine monotherapy. Artemether lumfantrin (AL), artesunate amodiaquin (AS-AQ), and artesunate mefloquine (AS+MQ) are the ACTs that are advised. Both partner medications must be reasonably effective for a combination therapy to be successful (Krishna *et al.*, 2024). Strong anti-malarial medications, artemisinins are also effective against gametocytes in the early stages of development. Since their 1972 introduction, there has only been one case of clinical resistance near the Thai-Myanmar border (WHO, 2011). Its half-life is brief, and it acts quickly. The companion medications, which typically have longer half-lives and function more slowly, gradually remove the remaining parasite load after they have cleared over 90% of it in the first six hours of delivery. Therefore, the number of parasites exposed to sub-therapeutic levels is reduced, which could play a role in the development and dissemination of the parasite (Makanga, and Krudsood, 2009).

2.9 Vaccines against malaria

According to Schijns and Lavelle (2011), vaccination is now the most efficient means of preventing infectious diseases and the main way that immunology contributes to human health. More than 30 years ago, vaccination against malaria was shown to be effective when people received the shot via repeated bites from irradiated, but still metabolically active, *Plasmodium falciparum*-infected mosquitoes (Arama and Troye-Blomberg, 2014). However, it has long been thought that injecting large amounts of irradiation sporozoites into humans for vaccine purposes is not a feasible option. However, the use of whole-organism vaccines has gained fresh momentum due to recent successes; (Shimp *et al.*, 2013) showed that injections of irradiation sporozoites many times resulted in enhanced protection for 80 vaccinated persons. Additional strategies use subunit malaria vaccines, such the one that is now the front-runner RTS,S (which fuses a piece of the hepatitis B surface antigen with the circum sporozoite protein obtained from *P. falciparum*, which has been shown to produce a fair amount of protection. The purpose of vaccination strategies is to induce protective memory immune responses in advance of infection, to provide protection in the case of encountering the disease-causing agent again (Arama and

Troye-Blomberg, 2014). Malaria vaccine development is an active research area with enormous challenges. As the parasite proceeds from a sporozoite through the liver stage to the replicating cycle of the blood stage, it undergoes morphological changes and displays antigenic variations (Rts *et al.*, 2012). This allows the parasite to evade the protective immune responses of the host. Therefore, persons with malaria do not develop long-term sterile immunity, which is frequently linked to recovery from a variety of other infectious diseases. Despite these challenges, laboratory studies in rats, monkeys, and human subjects that demonstrated that protective immunity was generated by attenuated sporozoites provide the strongest evidence that vaccination against malaria is achievable (Rts *et al.*, 2012; Arama and Troye-Blomberg, 2014).

2.10 Vectors control

One of the most prevalent vector-borne illnesses that is seen throughout tropical and subtropical areas is malaria (Kamaraju *et al.*, 2011). Malaria remains a serious public health issue in a number of nations, despite the significant progress made in recent years in controlling the disease. A key component in stopping the spread of malaria is vector control, which has lost some of its efficacy recently for a variety of administrative and technical reasons, such as inadequate or nonexistent adoption of substitute instruments. Of the different strategies available for vector control, the most successful are IRS and ITNs, including longlasting ITNs and materials (Kamaraju *et al.*, 2011). Although earlier DDT spraying proved incredibly effective in eradicating disease vectors, it also led to the development of insecticide resistance and made it difficult to control the resistant mosquito population. Chemical, biological, natural plant products, and environmental management are the main alternatives available for vector control efforts nowadays (Kamaraju *et al.*, 2011).

2.11 Rapid detection and management of malaria in Ethiopia

It is clear that a precise diagnosis is still necessary to target antimalarial medications, stop transmission, and facilitate case management. New diagnostic techniques and active case detection are necessary due to a decreasing level of transmission (Abebe *et al.*, 2018). Over the last ten years, Ethiopia has significantly increased the number of health professionals stationed throughout the nation and developed health institutions, including district hospitals, health centers, and health posts (Tsegaye and Bern, 2018). From 3612 in 2000 to 6604 in 2005, the overall number of health facilities in the country expanded gradually, reaching 20283 in 2016

(Hiwot *et al.*, 2018). Because of effective preventive and case management initiatives, the nation has made notable strides in the competition against malaria in the most current decades. Particularly considering the significant involvement of volunteers from the health development army and Health extension workers (HEWs) who offer community based care at the family level (Tsegaye and Bern, 2018). One of the opportunities to implement a combination of malaria prevention and control tools is the existence of HEWs at the grassroots level in the Ethiopian health system. They can participate in case management, identify foci of transmission, coordinate the operation of IRS and LLINs, conduct surveillance, and carry out information, education, and communication to prevent malaria transmission (Bugssa *et al.*, 2020). Additionally, the FMoH introduced RDTs to enhance diagnosis and ACT as the first line medication for treating *P. falciparum* malaria in 2004 (Hiwot *et al.*, 2018). Hence, the introduction of improved diagnostic facilities is providing timely, accurate and reliable results to support diagnosis, outbreak investigations, confirm clinical diagnoses, conduct accurate infectious disease surveillance, and direct public healthcare policy (Abebe *et al.*, 2018) in combination, all these factors facilitate the way to enter the path to elimination phase (Bugssa *et al.*, 2020).

2.12 Role of community in malaria control and elimination

Effective malaria control in Ethiopia requires the active participation and collaboration of the entire community. This includes public and private health professionals, associations, community-based groups, opinion and religious leaders, non-governmental organizations (NGOs), community health workers (CHWs), community drug distributors (CDDs), and elected community leaders (Wakgari *et al.*, 2008). These diverse stakeholders must fully commit to the planning and implementation of malaria control measures. This is crucial because the sociocultural, political, economic, and ecological factors, as well as the community's knowledge of the illness and preventive measures, vary across different locations. As a result, a single intervention approach cannot be applied uniformly across all communities. The choice of appropriate control methods for a specific community necessitates an understanding of the community's role and participation in malaria management programs. The use of community-based programs for malaria control has become a common approach in many endemic countries, following the alma ata declaration on primary health care (PHC) in 1978. People's engagement is essential for the control or elimination of malaria, whether it happens now or in the future. In the

future, a lot will depend on the "community will" (Melanie *et al.*, 2004). The community must either actively participate in vector control or financially support vector control and elimination; it can no longer afford to be a spectator (Kibe *et al.*, 2006). Effective malaria control relied on local managements, health organizations, and the population's comprehension of the necessity and justification for malaria control. Using the potential of the local community was crucial to sustainable vector control (Agyepong, 1992). In general, community involvement and health education initiatives that raise awareness of malaria, stress the value of preventive measures, and develop an elimination strategy have been effective in lowering the disease's incidence in some developing nations (Lalleo *et al.*, 2006; Abebe and Bernt, 2018).

2.13 Malaria elimination in Ethiopia

Ethiopia is one of the priority countries targeted by the WHO's Global Malaria Eradication Program (GMEP) in the late 1950s. During this period, malaria was successfully eliminated in 37 countries, primarily in Europe and the Americas. However, further progress stalled, and the WHO shifted its strategy from eradication to malaria control in several countries, including Ethiopia, in the early 1970s (WHO, 1969; Mendis *et al.*, 2009; Najera *et al.*, 2011). Ethiopia's poor socioeconomic status and the country's complicated and diversified malaria risk distribution and transmission pattern were factors in the failure. There are very few references to the procedures, successes, and difficulties faced by Ethiopia during the eradication era. However, Madagascar and Swaziland described situations that might be comparable (Mendis *et al.*, 2009; Najera *et al.*, 2011). Throughout the course of the fieldwork, the student saw old automobiles, labels, and utensils that had been utilized in Ethiopia's malaria eradication effort strewn across malaria control offices and compounds nationwide. These could be essential to the development of the ongoing effort to eradicate malaria. Since 2004/2005, Ethiopia has continued to implement interventions and has shown a progressive decline in the number of deaths and cases of malaria (Aregawi *et al.*, 2014; Deribew *et al.*, 2017; Taffese *et al.*, 2018). It was among the first nations to adopt the concept of Scaling Up for Impact in the fight against malaria (Kamau, 2006; Bank, 2007). The fourth ambitious national strategy plan was developed in response to the lowering trend in malaria encumbrance reported in conjunction with the maintained reportage of malaria intrusions (FMOH, 2011; FMOH, 2017).

3.MATERIALS AND METHODS

3 .1.Description of the Study Area

3.1.1. location of study area

The study was done in Nono District, West Shoa Zone of Oromia National Regional State, Ethiopia. It has a total size of 693.7 square kilometers. The Nono district lies between 37° 20' 0"E and 8° 40' 0"N on a geographic map, with elevations varying from 1126 to 2192 m (Messay, 2011). The zonal capital, Ambo, is 101 km away from Nono District, while Addis Ababa is 216 kilometers away. It borders with Jibat district in the north, in the south Jimma zone, in southeast Southern Peoples Regional State, in the west Dano district, and in the east it borders with Ameya District of the Oromia region. Nono district constitutes a total of 33 rural and 2 urban kebeles. Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki are malarious kebeles where the study was conducted and found at 10 km from Silkamba town, the capital town of Nono district, to the south and southeast, respectively.

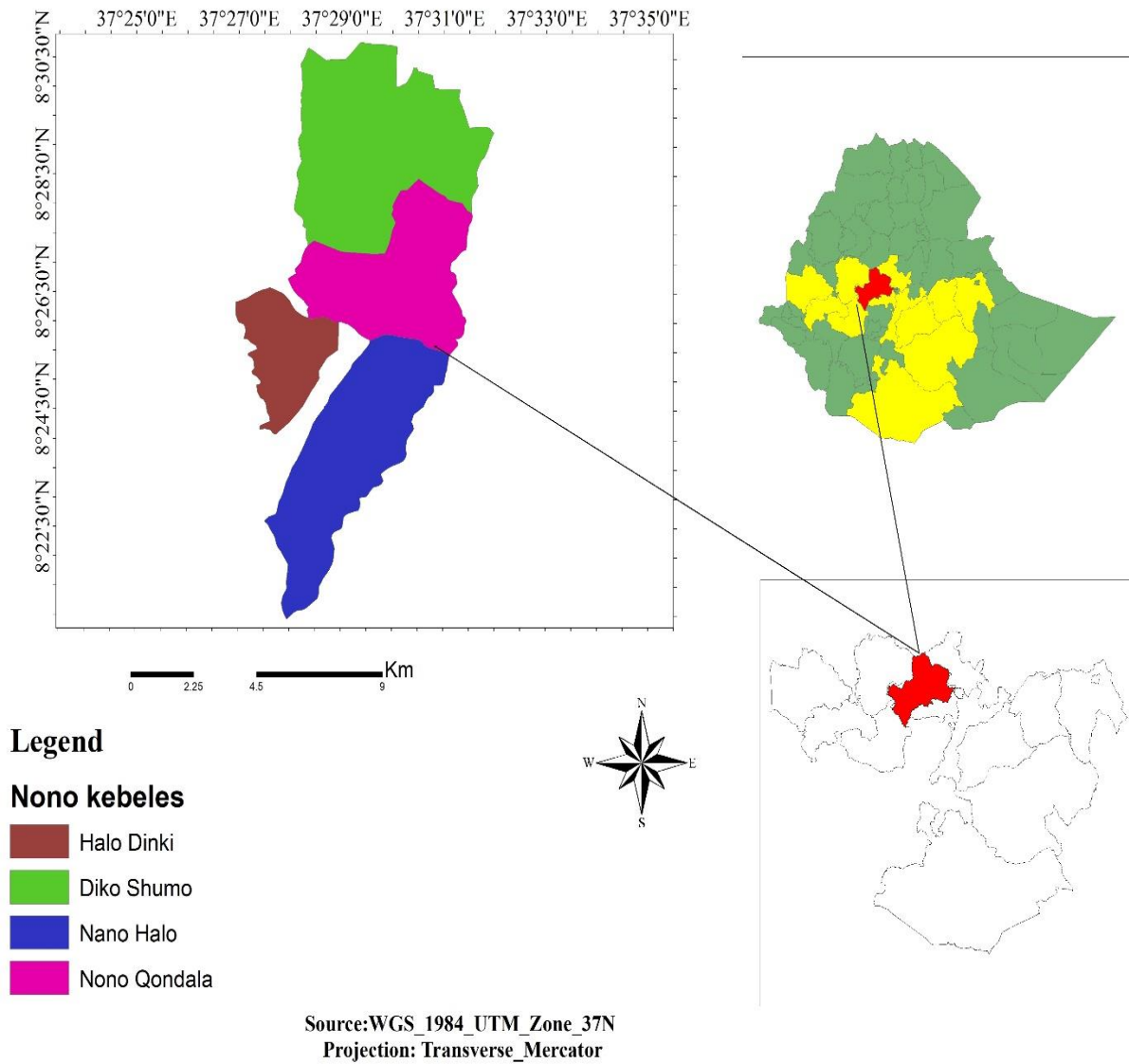


Figure- 2: Map of study area

3.1.2 Climate

Climatically, most parts of the Nono district belong to Badda Daree (middle altitude; 90.83 %) and Gammoojjii (low altitude; 9.16%) agro climatic zones (Messay, 2011). Table 1 presents a brief description of the sub-agro-ecological zones in the Nono district.

Table 1: Agro-climatic zone of Nono District

Characteristics	Agro-climatic zones			
	Moist qola (warm semi arid)	Wetqola (Semi- arid)	Moist Winadega (Semi humid)	Wet Winadega (humid)
Altitude (m asl)	500-1500	500-1500	1500-2400	1500-2400
Rainfall(mm)	800-1400	>1400	900-1400	>1400

Source: Limited fieldworks based on (Tegegn Samuel, 2014).

Its mean minimum and maximum temperature range from 18°C to 28°C respectively. The area has a bi-modal rainfall pattern, with the longer Meher season lasting from June to September, and the shorter Belg season occurring from March to May. 1039.8 mm is the average annual rainfall, distributed fairly throughout the year.

3.1.3. Population

According to data obtained from the Nono District Health Office in 2021, the district has an approximate total population of 126,062 inhabitants, fromt this total population 64,922 are male and 61,140 are female, and 112478 (89.2%) of whom live in rural areas and are mostly subsistence farmers depending on rainfed production systems, and 13,584 (10.8%) of its population are urban dwellers. Thus, the population density of the district is 182 persons per km². In Nono district, high malarious kebeles are Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki. specifically, the number of households is: Diko Shumo (421 households): 398 male-headed and 23 female-headed; Nano Qondala (592 households): 577 male-headed and 15 female-headed; Nano Halo (272 households): 260 male-headed and 12 female-headed; and Halo Dinki (311 households): 251 males and 60 females-headed (Woreda Agricultural and Natural Resource Office, 2021). There were 1596 households in the study area, with 1486 males and 110 females residing there. Since the four kebeles that were chosen are all rural, the people living in the research region were primarily farmers, with a small percentage of traders and laborers.

3.2 Study Design

Community-based cross-sectional household survey was conducted in 2023 G.C. in rural district of Nono which was known for a high incidence of malaria. The study utilized a combination of closed and open-ended questionnaires for selected individuals as respondents.

3.3 Sampling Technique and Sample Size Determination

3.3.1 Sampling Technique

From the study district, four malarious kebeles, such as Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki, were purposefully selected for this study. These sites were selected based on the fact that they have breeding sites for anopheles mosquitoes and the communities have serious malaria disease. The study was utilize a multistage sampling technique to select the participants. The first stage involves the random selection of villages within Nono district. In the second stage, households were chosen from each selected village using a systematic random sampling approach. Finally, within each household, eligible individuals were selected using a simple random sampling method.

3.3.2 Sample Size Determination

The study's sample size was determined using the single population proportion formula ($n = \frac{(z\alpha/2)^2 \times p(1-p)}{d^2}$) by taking a proportion of 50% because of the absence of data on the prevalence of malaria in the study area, a 95% confidence interval (CI) ($Z\alpha/2 = 1.96$), and a 5% margin of error ($d = 0.05$)

$$n = \frac{\frac{Z^2\alpha}{2} \times P(1-P)}{d^2} = \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} = 384.$$

Where n = sample size, Z = critical value at 95% certainty (1.96 at 95% CI), P =prevalence ($p = 0.5$), and d = marginal error 5% ($d = 0.05$), the total sample size is =384.

From the four selected malarious kebeles, the sample sizes of Diko Shumo (95 males and 3 females), Nano Qondala (105 males and 7 females), Nano Halo (85 males and 2 females), and Halo Dinki (73 males and 6 females) were selected systematically from the total population of Nono district. For the interview, eight interviewees were selected purposefully from four selected kebeles: four male model households and four female health extension.

3.4 Data collection tools

The tools used for data collection were questionnaire and interview .

3.4.1 Questionnaires

Structured questionnaires that include both closed open-ended questions were prepared and employed to generate quantitative and qualitative data, respectively from the respondents. It helped the researcher to gather detailed information about knowledge; attitude and malaria prevention practice of community as well as malaria prevalence in Nono district, Oromia region, western of Ethiopia. The questionnaire was created in English and then translated into Afan Oromo, the local tongue. The researcher or data collector were read the questions for selected illiterate respondents.

3.4.2 Interview

Interview was conducted individually to collect data on knowledge, attitude, prevention practice and prevalence of malaria in Nono district. Interviewees were selected from model householder and from health extension worker of the Nono district.

3.5 Inclusion and exclusion criteria

The respondents for the questionnaires and interviewees individually aged above 18 years living in the households of study area. For knowledge, attitude and practice (KAP) study, people who are > 18 years and permanent residents in the four kebeles of the district were included. Relatives coming during the study period were excluded. People who have been in the Kebeles for fewer than 6 months were also excluded from the study.

3.6 Pilot test

The draft of the questionnaire was first administered to 9 of Nono Health Center Workers (HCW) and 6 health extensions, who were doing in Nono district Health center and health extension and 4 model households of the selected malarious kebeles'. These health workers, who were selected for the pilot test, were not included in the final study as the sources of data. The pilot testing process helped the researcher to get feedback to improve ambiguous and unclear statements in the questionnaires. The final questionnaires were administered to the respondents only.

3.7 Ethical consideration

This study was conducted after proposal got consent by the advisor and department of Biology of Addis Ababa University and ethical clearance was secured from CNSC ethical clearance

committee. Before conducting the survey, discussion was undertaken with the Nono district health department and Kebeles administrative on the purpose of the study and then the study Communities were consulted for their permission. Then, based on their consent data were collected from each selected household.

3.8 Data analysis method

Quantitative analytical methods were employed in the analysis of data. Descriptive statistical method were used to summarize and analyze the data. The explanatory charts, tables, frequency, percentage and graphs were also used to summarize the data in precise form using the software programs such as Microsoft Excel and Statistical Packages for Social Sciences (SPSS) version 24. Data from interview were analyzed quantitatively based on their nature.

4.RESULT AND DISCUSSION

4.1. Socio-Demographic Characteristics Of The Respondents

A total of 384 individuals with a 100% response rate participated in the study (Table 2). Out of the total respondents, 362 (94.27%) and 22 (5.73%) were males and females, respectively, and were the main implementers of household activities in the study areas, including activities related to malaria prevention and control practice. The 26-35 age group dominated, accounting for 195 (50.78%) of the total number of respondents. Thus, this age group might become active participants in malaria prevention and control actions implemented at the household level (Table 2). Out of 384 respondents, 233 (60.67%) were married, followed by 73 (19.01%) who were single and 47 (12.25%) who were widowed. Only 31 (8.07%) of the respondents were divorced (Table 2). The types of respondents' occupations are presented in Table 2. The different occupational categories for all the respondents (N = 384) included the following categories: farmers 197 (51.3%), merchants 47 (12.25%), government employees or civil servants 35 (9.11%), daily laborers 51 (13.28%), and others or unspecified jobs 54 (14.06%). The illiteracy rate among the respondents (N = 384) of this study was 49 (12.76%), while the figure reported for those who could read and write was 103 (26.72%; Table 2). As shown in Table 2, implying that respondents learned up to primary school were 142 (36.77%), while 90 (23.5%) learned up to secondary school. The current study's finding is that the mainstream of Ethiopian citizens in the study zone belong to the Christian faith. Among the respondents (N = 384) to this study, 90 (23.45%) had 1–5 families in one household, while 6–8 were 184 (47.92%). As shown in Table 2, implying that respondents having more than nine family members were 110 (28.64%) Household size might affect some malaria prevention and control activities. About 37 (9.64%) of respondents had less than \$500 monthly income, while 236 (61.4%) had \$500-\$1000 monthly income (Table 2). Among all the respondents in the study area, 111 (28.91%) had more than 1000 birr per month in income. This low level of income was predictable since the respondents were from rural communities that did not have regular monthly incomes. The livelihood of countryside communities in Nono district depends primarily on resources such as livestock, animal products, and small-scale farm products like vegetables and fruits. Regarding mass media, several of the respondents, 169 (44.01%), used radio, while only 27 (7.03%) respondents

used TV as mass media (Table 2). On the other hand, 161 (41.9%) respondents did not have mass media in their home.

Table 2: Respondents' sociodemographic details

Variable	Category	Number	Percentage
Sex	Male	362	94.27
	Female	22	5.73
Age	18-25	107	27.86
	26-35	195	50.78
	≥36	82	21.36
Marital status	Single	73	19.01
	Married	233	60.67
	Divorced	31	8.07
	Widow	47	12.25
Occupation	Civil servant	35	9.11
	Farmer	197	51.3
	Merchant	47	12.25
	Daily laborer	51	13.28
	Other	54	14.06
Education	Illiterate	49	12.76
	Read and write	103	26.82
	Primary school	142	36.97
	Secondary school and above	90	23.45
Family size	1-5	90	23.45
	6-8	184	47.92
	≥9	110	28.64
Religion	Orthodox	114	29.70
	Muslim	99	25.78
	Protestant	85	22.13
	Catholic	0	0

	Wakefata	88	22.39
Monthly family income	<500	37	9.64
	500-1000	236	61.45
	>1000	111	28.91
Source of information	Tv	27	7.03
	Radio	169	44.01
	No	161	41.9

4.2 Knowledge, attitude and practice of malaria prevention

4.2.1 Knowledge on malaria

Almost all the respondents, 373 (97.13%), heard about and knew the term malaria, and accepted that malaria was one of the foremost health issues in Nono district and in the selected study sites (Table 3). The causes of malaria disease in the study area, the majority of respondents (347, or 90.36%) reacted as malaria disease is caused by the bite of mosquitoes, while 6 (2.87%) mentioned exposure to cold weather, rain (5, or 1.3%), the evil spirit (9, or 2.34%), bad air (4, or 1.04%), drinking bad water (10, or 2.6%), and a curse from God (3, or 0.78%). A large number (78.38%) of the residents of the study area caught malarial disease. Among those who said mosquito bites expose them to malaria, most (90.88%) replied that mosquitoes bite people during night (Table 3).

Table 3 Knowledge of respondents on cause of malaria

Item	Alternative	Frequency	Percentage
Do you know malaria?	Yes	373	97.13
	No	11	2.87
What causes malaria?	Exposure to cold weather	6	1.56
	Exposure to rain	5	1.3
	Evil sprit	9	2.34
	Bite of mosquitoes	347	90.36
	Bad air	4	1.04
	Drinking bad water	10	2.6

	A curse from God	3	0.78
Did you catch malaria disease?	Yes	301	78.38
	No	83	21.61
Mosquito biting time	Night time	349	90.88
	Day time	10	2.6
	Always	18	4.68
	Midday time	7	1.82

When asked about symptoms associated with malaria, the most common ones that people described were fever (95.83%), chills and shivers (98.17%), headache (95.83%), thirst (93.48%), joint pain (77.34%), backache (73.69%), and vomiting (67.96%) (Figure 4).

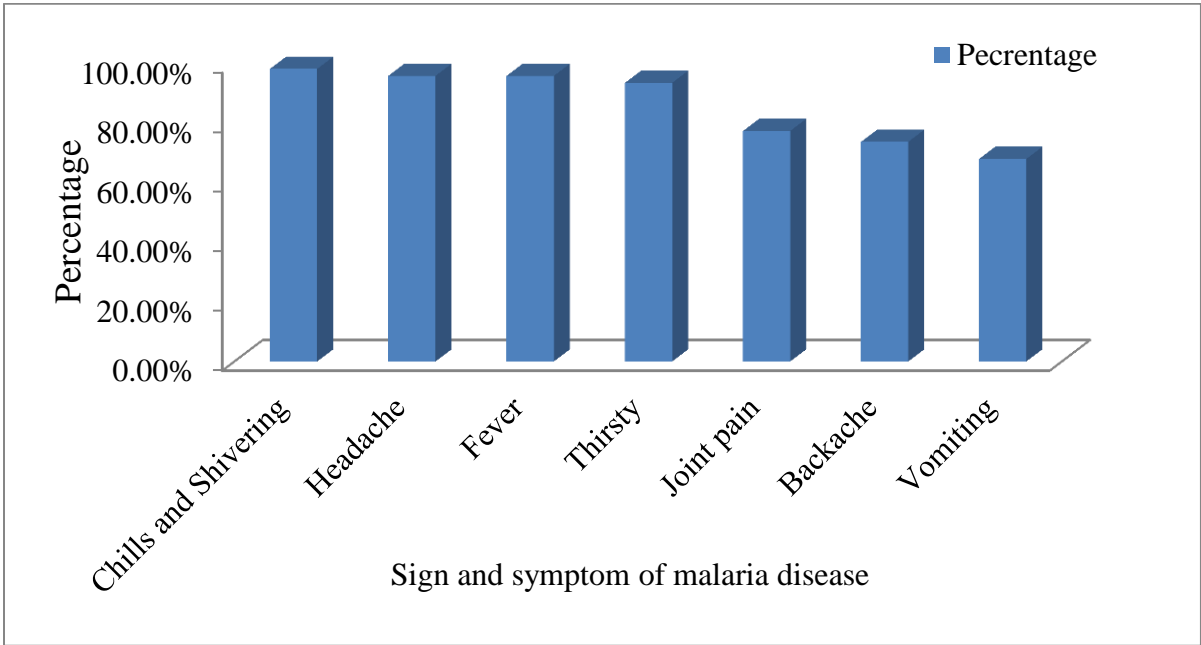


Figure 3: Knowledge of respondents on malaria symptoms

From the sum of 384 respondents, 373 (98.13%) knew that malaria could spread from person to person, but 11 (2.86%) did not believe in the transmission of this disease. Most of the respondents (80.98%) agreed that mosquitoes transmit malaria (Table 4). However, some of the study subjects believed that body contact with an infected person (3.9%), flies (3.38%), mother-

to-child (4.42%), breathing (0.78%), and malaria-infected blood transfusion (5.46%) could serve as transmission routes for malaria. In terms of knowledge of mosquito breeding grounds, a large number of the respondents (52.34%) accepted that mosquitoes breed in stagnant waters and swampy sites (Table 4). However, the rest (13.8%), (21.87%), and (11.97%), respectively, cited running water, waste material, and other sites (Table 4). The study participants, on the other hand, responded that mosquitoes rest in homes (68%), on dirty vegetation (54.42%), and on other places (3.91%). In Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki of the study area, 97.13% of the respondents claimed that malaria is a transmissible disease (Table 4).

As the data gathered from interviewee concerning, mosquito breeding sites, the interviewee responded as the presence of potential mosquito breeding sites, such as stagnant water, around the residence provides ideal conditions for mosquito populations to thrive. This increases the risk of mosquito-borne disease transmission.

Table 4: Knowledge respondents of on transmission, breeding site and biting time of mosquitoes (n=384)

Item	Alternative	Frequency	Percentage
Is malaria a transmissible disease?	Yes	373	97.13
	No	11	2.86
How is malaria transmitted from person to person?	Through bite of mosquitoes	311	80.98
	Through body contact with infected person	15	3.9
	Through breathing	3	0.78
	By flies	13	3.38
	Mother to child	17	4.42
	Infected blood transfusion	21	5.46
	Others	4	1.04
Mosquitoes breeding site	Stagnant water	201	52.34
	Running water	53	13.8
	In or on waste material	84	21.87
	Others	46	11.97
Mosquito resting site during day time	Unclean vegetation	209	54.42
	In the house	68	17.71

I do not know	15	3.91
Others	92	23.96

The majority of respondents (95.83%) believed that malaria is a preventable disease (Table 5). The rest of the 16 (4.17%) didn't agree that malaria is preventable. Out of the 384 respondents, 103 (26.82%) replied that children < 5 years and pregnant women (91, 23.69%) are more vulnerable than other age groups, while children aged ≥ 5 years (21.61%) were also claimed to be vulnerable. On the other hand, breast-feeding mothers (13.28%), old people (8.07%), and adult males (6.51%) were the least vulnerable age groups in the study area (Table 5). A large number of the respondents (76.82%) sprayed chemicals to control mosquito bites in their houses (Table 5). Only 187 (48.69%) of the respondents sprayed DDT in their living houses, whereas others used neem extract (22.65%), garlic extract (11.72%), and others (16.94%).

Table 5 : Knowledge of respondents on vulnerability and prevention (n=384)

Item	Alternative	Frequency	Percentage
Is malaria a preventable disease?	Yes	368	95.83
	No	16	4.17
Who is most vulnerable to malaria in the family?	Children <5	103	26.82
	Children ≥ 5	83	21.61
	Pregnant women	91	23.69
	Breast feeding mothers	51	13.28
	Adult male	25	6.51
	Old people	31	8.07
Do you spray chemicals to control mosquito bite?	Yes	295	76.82
	No	89	23.18
Which chemical/s/ or botanicals do you spray in your house?	DDT	187	48.69
	Garlic extract	45	11.72
	Neem extract	87	22.65
	Others	65	16.94

4.2.2 Attitude of the respondents on malaria in the study

As the attitude toward treatment seeking is indicated in Figure 4, 153 (39.84%) take traditional medicine, followed by the health extension center (135 (35.15%). Other respondents mentioned that self-treatment 73 (19.09%), hospital 62 (16.14%), referral hospital 21 (5.46%), and 20 (5.21%) desired to go to a private pharmacy (Figure 4).

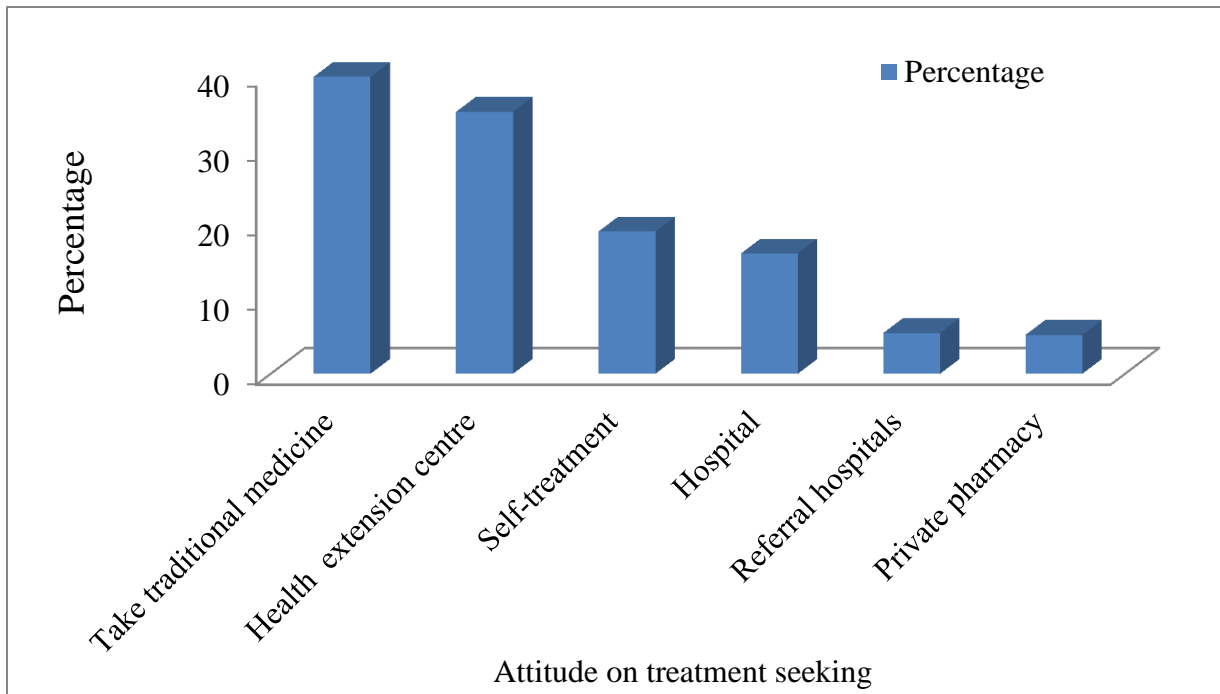


Figure 4: Attitude of respondents on treatment seeking

Practically, 334 (86.97%) strongly agreed and 50 (13.03%) agreed, as all respondents identified malaria as one of the significant health issues in the study area. Everybody in Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki is at risk of getting malaria, as the data gathered shows that 87.23 strongly agreed, 41 (10.67%) agreed, and 8 (2.1%) were not determined. Regarding guests coming from other places to the study site, about 155 (40.36%) agreed and 147 (38.18%) Strongly agree, while 82 (21.35%) were not determined, as guests coming from other places to the Nono district of the study area were at risk of getting malaria disease. Concerning the side effects of gating malaria disease that could cause anemia in pregnant women the majority of respondents, 305 (79.42%), strongly agreed, and 66 (17.18%) agreed, whereas 13 (3.38%) did not determine if gating malaria can cause anemia in pregnant women. On the subject of whether

their family is at risk of getting malaria, 212 (55.21%) strongly agreed and 108 (28.12%) agreed that malaria disease is a risk for their family, while 64 (16.66%) did not determine whether malaria disease is a risk to their family (Table 6).

Table 6: Attitude of respondents on malaria disease

Item	Alternative	Frequency	Percentage
Malaria is a health problem in these Kebeles.	Strongly agree	334	86.97
	Agree	50	13.03
	Not determined		
	Disagree		
	Strongly disagree		
Everybody in this village is at risk of getting malaria.	Strongly agree	335	87.23
	Agree	41	10.67
	Not determined	8	2.1
	Disagree		
	Strongly disagree		
Guests coming from other places to our home are at risk of getting malaria	Strongly agree	147	38.28
	Agree	155	40.36
	Not determined	82	21.35
	Disagree		
	Strongly disagree		
Malaria causes anemia in pregnant women	Strongly agree	305	79.42
	Agree	66	17.18
	Not determined	13	3.38
	Disagree		
	Strongly disagree		
My family is at risk of getting malaria	Strongly agree	212	55.21
	Agree	108	28.12
	Not determined	64	16.66
	Disagree		
	Strongly disagree		

4.2.3 Malaria prevention practice

Regarding the prevention practice of malaria (Figure 5), almost all (99.21%) of the respondents thought that the use of bed nets could prevent malaria, followed by removal of standing water (98.69%), apply insecticide to the house. (96.61%), taking tablets or drugs (92.44%), using traditional medicine (84.11%), closing windows and doors (81.25%), fumigation (42.44%), boiling drinking water (40.63%), clearing vegetation (38.54%), and using aerosols (31.77%).

According to data collected through interview, the net is hung over the bed, showing that bed net usage is being practiced. However, the net is not hung in the appropriate position, which reduces its effectiveness in preventing mosquito bites. Concerning net condition, the net is not hung properly, which compromises its ability to provide a physical barrier against mosquitoes. The improper hanging may be due to a lack of awareness or understanding on how to correctly install the net. Regarding net handling knowledge, the interviewee's limited knowledge on how to proper tack the net suggests a need for education and training on the correct installation and maintenance of bed nets.

All in all, the interview results disclose several factors that contribute to the increased risk of mosquito-borne disease transmission in the household, including the presence of mosquitoes, improper bed net usage, lack of window/door screening, potential breeding sites, and poor housing conditions. Addressing these issues through education, proper net installation, environmental management, and housing improvements would be crucial to reducing the risk of mosquito-borne diseases in this scenery.

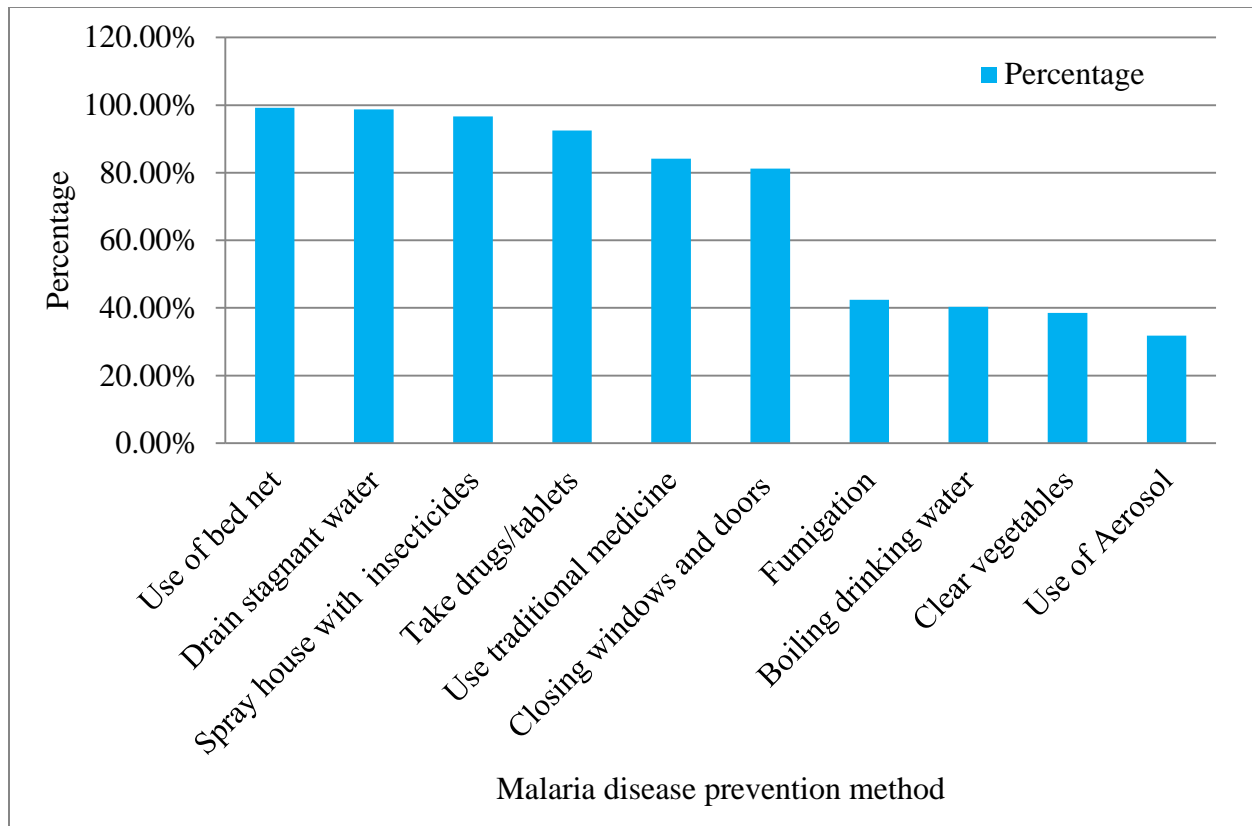


Figure 5: Respondents' practice on malaria prevention methods

Most (95.05%) of the respondents heard about insecticide-treated nets (ITN), whereas 19 (4.95%) didn't hear about ITN in the Nono district of selected malarious kebeles (Table 7). About 44% of the respondents heard information about ITN from radio, followed by health professions (24.74%). Some (32.81%) respondents heard about ITN very seldom, followed by at least once a week (25%). Regarding training given by concerned bodies on malaria prevention practice, a few (16.4%) of the respondents participated, while the majority (83.6%) of the respondents did not take part in the training (Table 7). The household head (10.67%), housewife (3.13%), and son or daughter (2.6%) got training on increasing awareness of malaria prevention practices (Table 7).

Table 7: Source of the information about ITN and its accessibility in the study area

Item	Alternative	Frequency	Percentage
Have you ever heard about ITN?	Yes	365	95.05
	No	19	4.95
Source of your information about ITN	TV	27	7.03
	Radio	169	44.01
	Health professionals	95	24.74
	Family	24	6.25
	Friends	33	8.59
	Others	36	9.37
How often have you received the information?	Everyday	89	23.17
	At least once a week	93	25
	1-3 times a month	57	14.06
	Very seldom	126	32.81
	Have never received	19	4.16
Training on malaria prevention	Yes	63	16.4
	No	315	83.6
Who was trained from the family?	Household head	41	10.67
	House wife	12	3.13
	Son/daughter	10	2.6

According to Table 8, about (84%) of those surveyed had heard about mosquito nets, while 61 (16%) respondents didn't hear about mosquitoes. A large number of respondents (81%) heard about mosquito nets, whereas 19% of the respondents did not have mosquito nets. The main target of the net of mosquitoes was mainly used to protect from mosquito bites or kill mosquitoes (40.1%), followed by preventing the entry of mosquitoes (32.55%). And a few (14.58%) mentioned it repels mosquitoes, while others import 49 (12.76%) believed that ITN protected them from other insects. They were used by young people 373 (97.13%), children younger than five years old 361(94.01%), pregnant women 365(95.05%), all age groups 345 (89.84%), and elderly people 165 (42.96%). Concerning the time to use ITN, the most respondents 273 (71.09%) used it always during the night, during the rainy season 77 (20.06%),

and after feeling the symptoms 8(8.55%). On the subject of the number of mosquito net possessions, the number of ITN is not enough for whole family members. As data described below in Table 8, only 55 (14.32%) respondents do have enough mosquito nets.

Table 8: Malaria prevention practice of communities on use of ITN (n=384)

Item	Alternative	Frequency	Percentage
Do you know mosquito net?	Yes	323	84
	No	61	16
Do you have ITN?	Yes	311	81
	No	73	19
What is the purpose of ITN?	Kills mosquitoes	154	40.1
	Prevent entry of mosquitoes	125	32.55
	Repels mosquitoes	56	14.58
	Others	49	12.76
Who should use bed net? (more than one answer is possible)	Children under 5 years	361	94.01
	Pregnant women	234	60.93
	Elderly people	165	42.96
	Young people	373	97.13
	All age groups	345	89.84
When to use ITN?	Always during the night	273	71.09
	Always during the day time	-	-
	During dry season	-	-
	During rainy season	77	20.06
	After feeling the symptoms	34	8.85
Is the number of ITN enough to whole family members?	Yes	55	14.32
	No	329	85.68

4.3 Discussion

According to data gathered from respondents in this study, a total of over 97% of the respondents knew malaria and accepted it as a disease and the result of this study is almost similar to the study conducted in a slum setting in Kenya, where all the respondents (100%) demonstrated awareness of malaria as a disease (Karanja (2002)). Regarding the cause of malaria, the findings of this study showed that malaria disease is caused by a bite of mosquitoes, and similar findings were reported by Karanja (2002) from southern regions of Ethiopia. According to the data gathered in this study, the number of respondents who had misunderstandings about the cause of malaria in this study was 9.64% (n = 37). An investigation reported in south-west Ethiopia showed a higher percentage of respondents with misconceptions about malaria despite living in malaria-endemic areas (Yewhalaw *et al.*, 2010b). In contrast, in another study from the central part of Ethiopia, the percentage of respondents who answered the cause of malaria with factors other than mosquito bites such as lack of personal hygiene, hunger, and chewing maize (Abate *et al.*, 2013). This finding suggests that despite efforts to increase awareness among the different parts of Ethiopian population, a high level of knowledge about the cause of malaria persisted among various groups in the research area (FMOH, 2012a). Ninety-one percent of those who took part in the study said that mosquitoes bite people at night. It was comparatively similar to the 83.8% study published in Shewa Robit (Tesfay *et al.*, 2017).

The results are consistent with previous research by Abate *et al.*, (2013) and Tesfay *et al.* (2017) regarding the signs and symptoms of malaria in the study area, which included fever, headache, chills, shaking, lack of appetite, and vomiting. Comparable findings were discovered in various knowledge, attitude, and preventative behavior studies conducted in various Ethiopian regions (Haile *et al.*, 2015; Yimer *et al.*, 2015).

In Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki of the study area, 97.13% among the responders claimed that malaria is a transmissible disease, and the result of this study is higher than the investigation from the survey conducted in Eddo Kontola in the Zwai area of central Ethiopia WHO, (1999). The result of this study is relatively similar to the report of Tesfaye, (2004) who verified that 94.3% of the respondents in Gondar town believed that malaria was a preventable disease. Furthermore, the findings of this study are consistent with those of other studies carried out in various regions of Ethiopia, including Abate *et al.* (2013), Mitiku and

Assefa (2017), Tesfay *et al.* (2017), Alealign and Petros (2018), where the majority of participants (97%) thought that malaria is a disease that can be prevented and treated. However, this result was in opposition to a study carried out in central Ethiopia, where 77% of the inhabitants believed that malaria could not be avoided Yeneneh *et al.* (1993).

Regarding mosquito breeding sites, 52.34% of respondents claimed that stagnant water is the main site (Table 4), which is higher than the result (34.0%) from Gamo Gofa Zone reported by Temam *et al.*, (2017) but less than the result (72.6%) from Amhara National Regional State, Northern Ethiopia, by Aderaw and Gedefew, (2013).

In this study, the majority of the respondents understood that malaria is a preventable disease, comparable to the previous studies carried out in Ethiopia by Alemu *et al.*, (2012). In the current study, 48.69% of respondents sprayed their houses with DDT, which is less than the research carried out in Shewa Robit, Ethiopia, where 70.4% reported Zewdie and Molla (2013). Similarly, the present study's result is lower than the findings (61.7%) published in the Gamo Gofa Zone, southern Ethiopia (Temam *et al.*, 2017), but it is equivalent (48%) to the results of a study done by Zewdie and Molla (2013) in the Amhara National Regional State, northern Ethiopia. The frequency of malaria infection in this study was 26.82% detected in the age group <5 years, followed by pregnant women (23.69%) (Table 5). This might be due to lower immunity to malaria infection in children under five years of age, as reported earlier by Delelegn *et al.* , (2020).

Treatment-seeking behavior is essential for quick case detection and management so that transmission is reduced. However, the obligation among a few participants to bring people with fever to health facilities within one days the beginning of the clinical signs remains low, and they rely on the use of self-administered drugs and traditional medicines, which are common practices in parts of Africa. Abuya *et al.*, (2007), and DePina *et al.*, (2019) are highly similar to this investigation. In contrast, the result of this study was lower than the reports of Bogale *et al.* (2021), as 91.4% of respondents said that they sought treatment from a health center (5.6%), while 3% practiced self-medication by procuring drugs from drug stores and using traditional medicines such as garlic and the leaf of a neem tree, respectively. Generally, the results of this study were relatively similar to the report stated, as treatment-seeking behavior for malaria diseases showed enhancements from corner to corner of the country in recent reports by EPHI (2015).

As the data was recorded from the study area, all stakeholders 100% realized that malaria was among the leading health issues of Nono district in selected malarious kebeles, and the result of this finding was highly similar to a survey conducted and reported in different regions of Ethiopia and elsewhere, as malaria is a major public health issue in developing countries. Nevertheless efforts made by several countries Hakizayezu *et al.*, (2022). The results of this study were 100% higher than the report of Bogale (2021), which revealed that 97% of the respondents recognized malaria disease as a serious health problem.

As data was gathered, taking drugs, using mosquito nets, draining stagnated water (mosquito breeding sites), and treating houses with insecticides were the main types of malaria preventive measures frequently reported by the present study participants, as reported by previous investigators from the Amhara region, Abate *et al.*, (2013), Mitiku and Assefa (2017), Tanzania Munisi *et al.*, (2019), and Iran Madani (2017). The results of this study are greater than those of studies done elsewhere by Bogale *et al.* (2021), where taking drugs (86.3%), using mosquito nets (73.3%), draining stagnated water (68%), and treating houses with insecticides (66%) were mentioned as the main malaria prevention practices.

Virtually 95% of the respondents heard about ITN and this result is higher than reports in different parts of Ethiopia Tesfay *et al.* (2017). From the total residents of the study area, only 44.01% of households had use mass media such as radios, about 7.03% heard from television (Table 7). This finding is low compared to that reported by the national malaria indicator survey conducted in Ethiopia by Hwang *et al.*, (2010). According to data collected from respondents, only 24.74% of the respondents had received information from health workers serving at government health facilities, and the findings of this investigation are consistent with the Hwang *et al.*, (2010) publication. The result of this study about ITN was similar to different reports in different parts of Ethiopia. On the other hand, the ITN coverage of 81% observed in this study was higher than the reported values of 21.5% Biadgilign *et al.* (2012), 33.5% Gobena *et al.*, (2013), and 60.6% Batisso *et al.*, (2012). However, the number of ITN is not enough for whole family members, according to the data collected from the households. As the result of this finding, young people (97.13%) got first priority, followed by children under 5 years (94.01%), to use mosquito nets. This result was similar to different reports, and further study showed that most of the communities give priority to younger people and children under five years to sleep under bed nets, which is comparable with results reported from other studies in different parts of Ethiopia Haile *et al.* (2015); Tesfaye *et al.* (2017). But the result of this finding regarding the use of mosquito bed nets concerning pregnant women was less than the report of Tesfay (2017) and other surveys conducted in Ethiopia elsewhere.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Knowledge, attitude, and practice survey undertaken in Diko Shumo, Nano Qondala, Nano Halo, and Halo Dinki Kebeles, found in Nono District, asked for the cause of malaria. Important information on the current status of malaria control measures has been gleaned from the study on the knowledge, attitude, and practices of the community regarding the prevention of malaria in Nono District. The results show that although the community has a fundamental awareness of how malaria spreads and how to avoid it, there are large gaps in the practical application and attitude support for these actions.

The community's knowledge about malaria is generally adequate, but the actual practices of malaria prevention are not consistently aligned with recommended guidelines. This disconnect suggests a need for targeted educational interventions that not only enhance knowledge but also translate into actionable practices. Additionally, addressing negative attitudes and increasing community engagement in malaria prevention efforts will be crucial for improving the overall effectiveness of control measures. To address these issues, it is recommended that local health authorities focus on comprehensive education programs that also address common misconceptions and barriers to effective prevention. Increasing the availability and accessibility of preventive tools, such as insecticide-treated nets and mosquito repellents, is also essential. Furthermore, ongoing research should explore the effectiveness of these interventions and identify additional strategies to overcome practical challenges faced by the community.

Overall, there is potential to greatly enhance malaria prevention and control in Nono District by addressing the identified gaps in knowledge, attitudes, and practices, which would improve health outcomes and lower the incidence of malaria.

5.2 Recommendations

The knowledge, attitudes, and practices of the community about malaria infection, care, and prevention were found to be encouraging in this study. Even yet, given what they know, the malaria frequency in the Nono district that was chosen for the malarious kebeles is concerning

for a pandemic. The following suggestions were sent in light of the research's findings: To encourage community members to practice malaria prevention methods all the time, health sector officials should increase accessibility and awareness of malaria prevention methods.

- Health professions and societies should consider environmental management, and the community should be trained to practice sustainable and integrated vector control measures, including the drainage or stagnant water of breeding sites, to play a crucial role in preventing the occurrence of malaria epidemics.
- Government and non-government organizations should dispense key vector control facilities like insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS) for rural communities, especially those with low monthly incomes, to control malaria.
- Healthcare provision and advice should include education to increase community awareness and practice about the transmission and prevention of malaria in the study area.

6. REFERENCES

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7. APENDIX-I

I. Socio-demographic Characteristics

Sex-----

Age-----

Marital status-----

Occupation-----

Educational level-----

Family size-----

Religion-----

Monthly family income sources and amount-----

Mass media types owned-----

II. Knowledge, Attitude and Practice

S/N	Questions	Alternative answers	Code
017	Do you know malaria?	1. Yes 2. No	/----/
	If yes to question no 017, what causes malaria?	1.Exposure to cold weather 2.Exposure to rain 3. Evil sprit 4. Bite of mosquitoes 5. Bad air 6. Drinking bad water 7. A curse from God 8. Other specify-----	/----/ /----/ /----/ /----/ /----/ /----/ /----/ /----/
018	Did you catch malaria disease?	Yes? No?	
019	Mosquito biting time	1. Night time 2. Day time 3. Always 4. Midday time	
020	What are the signs and symptoms of malaria? (more than one answer is possible)	1. Fever 2. Chills and Shivering 3. Headache 4. Backache 5. Joint pain 6. Vomiting	/----/ /----/ /----/ /----/ /----/ /----/

		7. Thirsty 8.Others,ecify-----	/----/ /----/
021	What do you do when you feel malaria signs/symptoms??	1. Visit the nearby health centre 2. Visit referral hospitals 3. Undergo self-medication 4. Take traditional medicine 5. I do nothing	/----/ /----/ /----/ /----/ /----/
022	Is malaria a transmissible disease?	1. Yes 2. No (skip to Q 021) 3. I do not know(skip to Q20)	/----/ /----/ /----/
023	If yes, how is malaria transmitted from person to person?	1.Through bite of mosquitoes 2.Through bodily contact with infected person 3.Through breathing 4.By flies 5. Mother to child 6. Infected blood transfusion 7. Others, specify-----	/----/ /----/ /----/ /----/ /----/ /----/
024	When do mosquitoes mostly bite?(more than once answer is possible)	1. Day time 2. At night 3. I do not know	/----/ /----/ /----/
025	Where do mosquitoes mostly breed? (More than one answer)	1. Stagnant water and swampy areas 2. In the running water 3. In or on waste material 4. Others, specify-----	/----/ /----/ /----/ /----/
026	What is the mosquito resting site during day time? More than one	1. Unclean vegetation 2. In the house 3. I do not know 4. Others, specify-----	/----/ /----/ /----/ /----/
027	Who is most vulnerable to malaria in the family?	1. Children less than five years of age 2. Children five years of age and above 3. Pregnant women 4. Breast feeding mothers 5. Adult male 6. Old people 7.Others, specify-----	/----/ /----/ /----/ /----/ /----/ /----/ /----/
028	Is malaria a preventable disease?	1. Yes 2. No (skip to Q 027) 3. I do not know(skip to Q 028)	/----/ /----/ /----/
029	If yes to question number----, what methods do you know to prevent malaria?	1. Take drugs/tablets 2. House spray with residual insecticides 3. Drain stagnant water	/----/ /----/ /----/

	(more than one answer is possible)	4. Clear vegetables 5. Use of bed net 6. Boiling drinking water 7. Fumigation 8. Use of Aerosol 9. Closing windows and doors early in time 10. Use traditional medicine 11. Others, specify-----	/----/ /----/ /----/ /----/ /----/ /----/ /----/
030	Do you spray chemicals/botanicals (garlic/neem extracts) to control mosquito bite?	1. Yes 2. No	/----/ /----/
031	If your answer to question---- is YES, which chemical/s/ or botanicals do you spray in your house?	1. DDT 2. Other chemicals, specify----- 3. Garlic extract 4. Neem extracts 5. Other botanicals, specify-----	/----/ /----/ /----/ /----/ /----/
032	Have you ever heard about Insecticide Treated Net (ITN)?	2. Yes 3. No	/----/
033	If yes to Q 027, can you tell us the source of your information about ITN?	1. TV 2. Radio 3. Health professionals 4. Family 5. Friends 6. Others, specify-----	/----/ /----/ /----/ /----/ /----/ /----/
035	Have you received any information on malaria from health workers?	1. Yes 2. No 3. I don't remember	/----/
036	If yes to question 029, how often have you received the information?	1. Everyday 2. At least once a week 3. 1-3 times a month 4. Very seldom 5. Have never received	/----/
037	Have you received awareness creation training on malaria prevention methods??	YES NO	/----/ /----/
038	If your answer is yes to question-----, who arranged the training?	1. Health workers 2. Teachers 3. Kebele officials 4. Agricultural workers 5. Students	/----/ /----/ /----/ /----/ /----/

		6. Others, specify-----	
039	If you have received health information on malaria, was it helpful to you?	1. yes, it was very helpful 2. yes, it was helpful 3. No, it was not helpful	/----/
040	Have you used traditional herbs to prevent mosquitoes?	1. Yes 2. No	/----/ /----/
041	Have you been given any orientation about use of ITN?	1. Yes, 2. No	/----/ /----/
042	If yes to Q 033, who was trained from the family?	1. Household head 2. House wife 3. Son/daughter 4. Others, specify-----	/----/ /----/ /----/ /----/
043	Do you know mosquito net?	1.Yes 2. No	/----/ /----/
044	Do you have ITN?	1.Yes 2. No	/----/ /----/
045	If your answer to question number---- is NO, what could be the reason/s/?	1. lack of access 2. lack of awareness 3. other reasons, specify-----	/----/ /----/ /----/
046	What is the purpose of ITN?	1. Kills mosquitoes 2. Prevent entry of mosquitoes towards family members using them 3. Repels mosquitoes 4. Kills malaria parasites 5. Others (specify-----	/----/ /----/ /----/ /----/ /----/
047	Who should use bed net?	1. Children under 5 years 2. Pregnant women 3. Elderly people 4. Young people 5. All age groups 6. I do not know	----/ /----/ /----/ /----/ /----/ /----/
048	When to use ITN?	1. Always during the night 2. Always during the day time 3. During dry season 4. During rainy season 5.After feeling the symptoms	/----/ /----/ /----/ /----/ /----/
049	Is the number of ITN enough to whole family members?	1. Yes 2. No	/----/ /----/

You carefully listen to the statements and tell me your level of disagreement or agreement using

the key terms: ‘strongly disagree’, ‘disagree’, ‘not determined’, ‘agree’ or ‘strongly agree.’”

1. Strongly agree 2. Agree 3. Not determined 4. Disagree 5. Strongly disagree

050	Malaria is a health problem in this Kebele?	1 2 3 4 5	/----/
051	Everybody in this village is at risk of getting malaria.	1 2 3 4 5	/----/
052	Guests coming from other places to our home are at risk of getting malaria	1 2 3 4 5	/----/
053	Some people are more prone to getting malaria than others	1 2 3 4 5	/----/
054	Malaria causes anemia in pregnant women	1 2 3 4 5	/----/
055	I am at risk of getting malaria	1 2 3 4 5	/----/
056	My family is at risk of getting malaria	1 2 3 4 5	/----/

Rarraatuu: I

Amala Hawaasummaa gafatamtootaa

S/N	Questions	Alternative answers	Code
011	Saala	1.Dhiira 2.Dhalaa	/----/
012	Umuriin kee meeqa?	----- waggaadhaan	/----/
013	Haala gaa'elaa	1.Kan fuudhe/heerumte 2.Qeerroo/ Qarree 3.Kan maatiin jalaa du'e 4.Kan wal hiikan	/----/
014	Hojiin kee maalii?	1.Hojjetaa mootummaa 2. Daldalaa 3. Hojjetaa guyyaa 4. Qotee bulaa 5. Kan biroo-----	/----/
015	Haala barnootaa	1.kan hin baranne 2. Barreessuu fi dubbisuu danda'a/dandeessi 3. Kutaa 1 – 6 4. Kutaa 7 – 8 5. Kutaa 9-12 6. Dippiloomaa 7. Digirii fi sanaa ol	/----/
016	Haala amantaa	1.Oortodooksii 2.Musiliima 3.Protestaantii 4.Kaatolikii 5.Waaqeffataa 5.Kan biroo	/----/

Rarraatuu: II

Gaaffilee Beekumsaa, Ilaalchaa fi Ittisuuf Shaakaluuf

T/L	Gaaffilee	Filannoo dhiyaate	Koodii filatame
017	Dhukkubnni buusaa maal akka ta'ee beekta?	1 Eeyyen 2.Lakkii	/----/ /----/
018	Yoo deebii nkee G 07 eeyyee ta'ee dhukkubnii kun maalin nama qaba?	1 Eeyyen 2.Lakkii 1.Haala qilleensa qorraaf saxilamuun 2. Roobaan yoo saxilaman 3.Afuura hamaan 4.Ciniinnaa bookee busaa 5.Qilleensa faalamaan 6 .Bishaan faalamaa dhuguun 7.Abarsaa waqaan 8 Kan biroo _____	/----/ /----/ /----/ /----/ /----/ /----/ /----/
019	Mallattoon fi dhukkubbiin dhukkubaa buusaa maal faa'i?(deebiin tokko ol ni dandaa'ama)	1 Eeyyen 2.Lakkii 1. Hoo'a qaama 2. Qorrisisuu fi hoolachisuu 3. Mata boowoo 4. Dhukkubbii buusa 5. Ol deebisisuu 6. Dheebuu bishaanii 7. Kan biro _____	/----/ /----/ /----/ /----/ /----/ /----/
020	Dhukkubnii buusaa dhukkubaa daddarbuu dha?	1 eeyyen 2.lakkii 3. Hin beekuu	
021	Yoo deebiin kee G020 eeyyen ta'ee dhukkubni kun haala kamiin nama namaatti darba?	1 Eeyyen 2.Lakkii 1. Karaa ciniinnaa ilbiisaatin 2. dhukkubsataa tuttuquu 3. Karaa afuraan 4. Karaa tisisaan	/----/ /----/ /----/ /----/

		5. Haadha irraa gara daa'imaatii 6. Karaa liqeeffanaa dhiigaan 7. Kan biro_____	/----/ /----/
022	Yeroo baay'ee bookeen buusa yeroo kami nama ciniinuu dandeesi? (deebiin tokko ol ni dandaa'ama).	1.Guyyaa guyyaa 2.Halkaan halkaan 3.Hin beeku	/----/
023	Ilbiisa bookee buusaa bakkee akkamitti wal hortii?	1 Eeyyen 2.Lakkii 1.Bakka bishaan dhaabbataan jiru fi caaffa'aati 2.Naannoo bishaan yaa'an jirutti 3.Bakka meeshaalee gataman keessa fi irraatii 4.Kan biroo _____	/----/ /----/ /----/ /----/
024	Bakkeen boqoonnaa bookee buusaa yeroo guyyaa eessa ta'u dandaa'a? (deebiin tokko ol ni dandaa'ama)	1 Eeyyen 2.Lakkii 1. Biqiloota xixxiqoo hin qulqulloofnee jalaa 2. Naannoo mana keessa 3. Hin beekuu 4. Kan biroo_____	/----/ /----/ /----/ /----/
025	Miseensoota maatii keessa kamtuu irraa caalaa saxiilamaadha?	1. Daa'immaan waggaa 5 gadii 2. Daa'immaan waggaa 5 olii 3. Haadhoolii ulfaa 4. Haadhoolii haarmaa hoosisaan 5. Nama gaa'eessaa 6. Nama dulloomaa 7. Kan biroo_____	/----/ /----/ /----/ /----/ /----/ /----/
026	Dhukkubaa buusaa kanaa ittisuun ni dandaa'amaa?	1 Eeyyee 2.Lakkii	/----/

		3.Hin beeku	
027	Deebiin kee G 026 yoo eeyye ta'ee karaalee akkamiin ittisuu dandaa'ama?	1 Eeyyen 2.Lakkii 1. Qorichaa fudhaachuun 2. Keemikaalaa farra bookee mana keessa biifuun 3. Bishaan dhaabbataa yaasuun 4. Saaphanaa siree fayyadamuun 5. Bishaan dhugaatii danfisuun 6. Foddaa fi balbaalaa cufuun 7. Kan biroo _____	/----/ /----/ /----/ /----/ /----/ /----/ /----/
028	Waa'ee saaphanaa siree keemikaalaa cuphaamee dhageesse beekta?	1 Eeyyen 2.Lakkii	/----/
029	Yoo deebiin kee G 028 eeyyee ta'ee maaddii odeeffaannoo keetii eenyu?	1 Eeyyen 2.Lakkii 1. TV 2. Radio 3. Ogeessotaa fayyaa irraa 4. Maatii 5. Hiriyyaa 6. Kan biroo _____	/----/ /----/ /----/ /----/ /----/
030	Odeeffaannoo waa'ee dhukkubaa buusaa hojjeetoota fayyaa irraa fudhaatee beekta?	1 Eeyyee 2.Lakkii 3. Hin beekuu	/----/
031	Gaaffii 30 ffaaf eeyyen yoo jettee yeroo hamammiif fudhaatee?	1. Yeroo hundaa 2. Torbaanitti si'a tokko 3. Ji'atii si'a 1-3 4. Baay'ee tureen 5. Odeeffaannoo argaadhee hin beekuu	/----/
032	Odeeffaannoo waa'ee dhukkubaa buusaa hojjeetoota fayyaa irraa fudhaatee na fayyadeera jette yaada?	1 eeyyen 2.lakkii 3.waa'ee isaa hin beekuu	/----/

033	Bookee buusa to'achuuf qorichoota aaddaa fayyadamtee beekta?	1 Eeyyee 2.Lakkii	/----/
034	Waa'ee itti fayyadaamaa saaphanaa siree irraatti odeeffannoo argattee beekta?	1 Eeyyen 2.Lakkii	/----/
035	Gaaffii 034 lakkii yoo jetteemaatii keessan keessaa eenyutu leenji'ee?	1 Eeyyen 2.Lakkii 1. Abbaa warraa 2. Haadha warraa 3. Daa'imaan maatii keessaa 4. Kan biro_____	/----/ /----/ /----/ /----/ /----/
036	Saaphana siree beektaa?	1. Eeyyee 2.Lakkii	
037	Yoo deebiinkee G036 Eeyyee ta'e faayidaan saaphanaa siree maali?	1 Eeyyen 2.Lakkii 1. Bookee buusaa ajjeessa 2. Bookeen buusa akka bakka ciisichaa hin seenne ittisa 3. Ilbiisota siree irraa dhorka 4. Kan biroo_____	/----/ /----/ /----/ /----/ /----/
<p>Gaaffanoolee armaan gadii akkaataa itti amanuu dandeessuu irraatti hundaa'u filaachuun deebisii</p> <ol style="list-style-type: none"> 1. <i>Sirriittin irraatti walii gala</i> 2. <i>Waliin gala</i> 3. <i>Hin beekamuu</i> 4. <i>Irraatti walii hin galuu</i> 5. <i>Sirriitti irraatti walii hin galuu</i> 			
038	Dhukkubnii buusaa rakkoo fayyaa naannoo kanaati.	1 2 3 4 5	/----/
039	Namoonnii naannoo kanaa hunduu dhukkubaa buusaf saxilamoodha	1 2 3 4 5	/----/
040	keessumoonnii naannoo biroottii as dhuufan rakkoo dhukkubaa busaa	1 2 3 4 5	/----/

	saxilamoodha.		
041	Namoonni tokko tokkoo carraa namoota biro caalaa dhukkubaa buusan saxilamuu qaba?	1 2 3 4 5	/----/
042	Dhukkubnii buusa hirii'ina dhiigaa dubaartoota ulfaa irraati fidu dandaa'a?	1 2 3 4 5	/----/
043	Anii dhukkubaa buusaf carraa saaxilamuu nanan qaba.	1 2 3 4 5	/----/
044	Maatiin koo carraa dhukkubaa buusan saaxilamuu qaba.	1 2 3 4 5	/----/

Part 2. Interview

INSTRUCTION: Please, make careful observation and fill the following information.

1. Is there a mosquito visible in the house?
1) yes 2) no
2. Was the net hanged over the bed/sleeping places?
1) Yes 2) No
3. If yes, what does the condition of the net look? (Circle those applicable)
1) Torn 2) Dirty
3) Not hanged on the appropriate position
4) Others, specify-----
4. Are there potential mosquito breeding sites (stagnant water) around the residence?
1) Yes 2) No 3) Difficult to identify
5. Do the windows and doors have screening?
1) Yes 2) No
6. Ask the interviewee if he/she knows how to tack net.
7. How do you describe the surface of the walls?
1) Very smooth
2) Smooth
3) Rough
4) Very rough with a lot of cracks
8. Does the house have openings that allow the entry of mosquitoes?
1) yes 2) No