HAWASSA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF MEDICAL LABORATORY SCIENCE

PREVALENCE AND ASSOCIATED FACTORS OF MALARIA AMONG THE COMMUNITY OF LOKA ABAYA DISTRICT, SIDAMA REGIONAL STATE, SOUTHERN ETHIOPIA

M.Sc. THESIS

BY: - SIRATU SEYOUM

OCTOBER, 2023

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PREVALENCE AND ASSOCIATED FACTORS OF MALARIA AMONG THE COMMUNITY OF LOKA ABAYA DISTRICT, SIDAMA REGIONAL STATE, SOUTHERN ETHIOPIA

A THESIS SUBMITTED TO THE TO THE SCHOOL OF MEDICAL LABORATORY SCIENCE, COLLEGE OF MEDICINE AND HEALTH SCIENCES, HAWASSA UNIVERSITY, FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR A MASTER OF SCIENCE DEGREE IN MEDICAL PARASITOLOGY

BY: SIRATU SEYOUM

ADVISOR: YARED MERID (Ph.D., ASSISTANT PROFESSOR OF MEDICAL MICROBIOLOGY)

CO-ADVISOR: SINTAYEHU FEKADU (Ph.D., ASSISTANT PROFESSOR OF MEDICAL MICROBIOLOGY)

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ADVISORS' APPROVAL SHEET

This is to certify that a thesis proposal entitled **"**Prevalence and associated risk factors of malaria among the community of Loka Abaya District, Sidama Regional State, Southern Ethiopia" submitted in partial fulfillment of the requirement for the degree of master in Medical Parasitology, to the graduate program of the School of Medical Laboratory Science, and has been carried out by Siratu Seyoum under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the school.

Name	**Signature**	**Date**
Yared Merid (Ph.D., Assistant Professor) (Main advisor)	_____	_____
Sintayehu Fekadu (Ph.D., Assistant Professor) (Co-advisor)	_____	_____

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We, the undersigned, members of the Board of Examiners of the final open defense by Siratu Seyoum have read and evaluated his thesis entitled **"**Prevalence and associated risk factors of malaria among the community of Loka Abaya District, Sidama Regional State, Southern Ethiopia" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the Degree of Master of Science in Medical Parasitology.

Name of examiners	**Signature**	**Date**
External Examiner:	_____	_____
Internal Examiner I:	_____	_____
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DECLARATION

I, undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sources or materials used for the thesis have been dully acknowledged.

This thesis, **"**Prevalence and associated risk factors of malaria among the community of Loka Abaya District, Sidama Regional State, Southern Ethiopia" is approved as the original work.

Name _____

Signature _____

Date _____

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LIST OF ACRONYMS AND ABBREVIATIONS

AOR	Adjusted-odds Ratio
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
COR	Crude- odds Ratio
FMOH	Federal Ministry of Health
HHs	Households
IRS	Indoor Residual Spray
ITN	Insecticide-Treatedal Nets
LLIN	Long-lasting Insecticide Net
PCR	Polymerase Chain Reaction
RBCs	Red Blood Cells
RDT	Rapid Diagnostic Test
SNNPR	Souther Nations, Nationalities, and Peoples Region
SOP	Standard Operating Procedure
SPSS	Statistical Package for Social Science
WHO	World Health Organization

ABSTRACT

Background: Malaria remains a major public health concern in Ethiopia, despite the widespread use of insecticide-treated mosquito nets. In most rural Ethiopian settings, insecticide-treated net coverage and proper use are major challenges. The goal of this study was to determine the prevalence of malaria, the proportion of *Plasmodium* species, and the risk factors for disease transmission in the study area.

Methodology: From April to May of 2023, a community-based cross-sectional study was conducted among 419 participants in Loka Abaya District, Sidama. A face-to-face interview and visual observation were used to collect socio-demographic data and other associated factors. A capillary blood sample from each study participant was collected and tested with smear microscopy and rapid diagnostic tests for the presence of malaria parasites. Epi-data manager version 4.6 was used to enter and clean the data, and SPSS version 26 was used to analyze it. Bivariate and multivariate logistic regression results were used to assess the association between the dependent and independent variables. Statistical significance was defined at p-value < 0.05.

Result: The overall prevalence of malaria infection was 61 (14.6%) with 95% CI: 11.0 - 18.0. The relative proportions of *P. falciparum* and *P. vivax* infection were 59.0% and 36.1% respectively, while the proportion of mixed (*P. falciparum* and *P. vivax*) infection was 4.9%. No formal education (AOR: 2.56; 95% CI: 1.10 - 5.94) compared to secondary and above education, low monthly income (AOR: 2.97; 95% CI: 1.07 - 8.25) compared to high monthly income, those who did not have ITN (AOR: 2.56; 95% CI: 1.14 - 5.75), never used ITN during sleep (AOR: 2.875; 95% CI: 1.130 - 7.317), living in areas with stagnant water (AOR=2.12, 95% CI: 1.14 - 3.99) were independent predictors of malaria infection.

Conclusion: The prevalence of malaria in the study population was high, with *P. falciparum* being the most common causative agent. Regarding associated factors, educational status, monthly income, ITN availability and utilization, and the presence of stagnant water around the house were all potential determinants of malaria. Continued community health interventions focusing on the proper use of ITN, drainage of stagnant water, and increased public awareness about reducing the risk of insect bites have the potential to reduce infection.

Keywords: - Malaria, Prevalence, Associated factors, Loka Abaya, Ethiopia

1. INTRODUCTION

1.1. Background

The word malaria is derived from two Italian words, ‘mal’ and ‘aria’ which mean “bad air” as it was thought that the disease is caused by bad air (Hennery, 2001). The common causes of human malaria are five *Plasmodium* species: *Plasmodium vivax (P. vivax), Plasmodium falciparum (P. falciparum), Plasmodium malariae (P. malariae), Plasmodium ovule* (*P. ovule)* and *Plasmodium knowlesi* (*P. knowlesi)*. The first four are only found in humans, *P. knowles*i is a zoonotic malaria parasite that is commonly spread throughout Southeast Asia in macaque monkeys (Sato, 2021). *P. vivax* and *P. falciparum* are responsible for the vast majority of malaria cases worldwide. Although *P. falciparum* causes more deaths, *P. vivax* has the highest global morbidity and the lowest mortality rates. It can result in severe, even fatal illnesses (Battle and Baird, 2021).

The main vector of malaria transmission is the female *Anopheles* mosquito. There are more than 400 known species of the *Anopheles* mosquito, and about 70 of these species potentially transmit malaria to humans; the principal species is *Anopheles arabiensis* (*An. arabiensis*), with *Anopheles pharoenesis* (*An. pharoenesis*), *Anopheles funestus* (*An. funestus*), and *Anopheles nili* (*An. nili*) serving as secondary vectors (Sinka *et al.*, 2012).

Malaria is a cyclical infection of humans and *Anopheles* mosquitoes. In humans, parasites grow and multiply first in the liver cells, then in the red blood cells (RBCs). In the blood, successive broods of parasites grow inside RBCs and destroy them, releasing daughter parasites (merozoites) that continue the cycle by invading other RBCs, these results in the typical signs and symptoms, which usually appear between 10 and 15 days after the mosquito bite. When certain blood-stage parasites (gametocytes, which emerge in male and female forms) are ingested by a mosquito during blood feeding, they mate in the mosquito's gut and begin a cycle of growth and multiplication. A sporozoite form of the parasite migrates to the mosquito's salivary glands after 10-18 days. When the mosquito feeds on another human, anticoagulant saliva is injected along with the sporozoites, which migrate to the liver and begin a new cycle (CDC, 2020a). If left untreated, malaria can be fatal due to the disruption of blood flow to vital organs and its complications include anemia, respiratory distress, hypoglycemia, and jaundice (Conroy *et al.*, 2019).

Malaria is one of the most severe public health problems worldwide. It is a leading cause of death and disease in many developing countries, where young children and pregnant women are the groups most affected (CDC, 2020b). According to the 2021 World Malaria Report; nearly half the world's population lives in areas at risk of malaria transmission in 87 countries and territories. In 2020, malaria caused an estimated 241 million clinical episodes and 627,000 deaths. An estimated 95% of deaths in 2020 were in the World Health Organization (WHO) African Region (WHO, 2021).

Malaria is a significant public health and economic problem in Ethiopia. Malaria distribution and transmission in Ethiopia varies from season to season due to altitude differences, climate, and rainfall patterns in areas with relatively longer duration of transmission in lowland areas, river basins, and valleys (Berhe *et al.*, 2019; Dabaro *et al.*, 2021). Bimodal transmission: Major transmission from September to December, following the main rainy season from June to August, and minor transmission: from April to May, following a short rainy period from February to March (Alelign and Dejene, 2016).

Ethiopia is one of the few African countries where both *P. falciparum* and *P. vivax* are co-endemic in significant numbers and are taken into account in malaria diagnostic and treatment guidelines (FMOH, 2017). *P. falciparum* is the most common accounting for approximately 60% of malaria cases, followed by *P. vivax* (40%). *P. falciparum* is endemic in many parts of the country. *P. malariae* and *P. ovale* infections are rare, accounting for less than 1% of confirmed malaria cases (Byrnes *et al.*, 2018). In Ethiopia, the *Anopheles* mosquito is the primary vector of malaria transmission. *An. arabiensis* is the primary vector, with *An. phronesis*, *An. funestus*, and *An. nili* serving as secondary vectors (FMoH, 2018). According to a recent study conducted in Awash Sebat Kilo, *An. stephensi* mosquitoes are well-established in an urban environment in Ethiopia (Tadesse *et al.*, 2021).

The Sidama Region has malaria-endemic areas as well as high-risk areas with mosquito breeding sites and potentially interrupting rivers. It has 173 malaria-endemic kebeles and 1,272,084 people at risk. Loka Abaya Woreda is one of the malaria-endemic areas in the region. It has 26 (100%) malaria kebeles, high-risk areas with mosquito breeding sites, and 110,917 populations at risk (Loka Abaya Woreda Health Office Annual report, 2021).

Knowledge of the local prevalence of malaria and its influencing factors is critical for designing and implementing cost-effective appropriate interventions. As a result, the purpose of this study was to determine the prevalence of malaria and its risk factors in the Loka Abaya community.

1.2. Statement of the Problem

Malaria is one of the most severe public health problems worldwide (CDC, 2020b). According to the 2021 World Malaria Report; nearly half of the world's population lives in areas at risk of malaria transmission in 87 countries and territories. In 2020, malaria caused an estimated 241 million clinical episodes and 627,000 deaths. An estimated 95% of deaths in 2020 were in the WHO African Region. In areas with high transmission (such as sub-Saharan Africa (SSA)), the most vulnerable groups are young children, pregnant women, and travelers or migrants (WHO, 2021).

Africa decreased the number of malaria cases by 38%, and the mortality rate decreased by 67% between 2000 and 2019 (WHO, 2020). The disruption in the provision of malaria services during the COVID-19 pandemic increased the case incidence by 232 per 1,000 populations at risk in 2020 (WHO, 2021). Between 2000 and 2015, the SSA cut malaria infections by 50% and clinical disease by 40%, due to the massive deployment of malaria control interventions such as long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS), prompt diagnosis, and treatment with effective antimalarial drugs; insecticide-treated nets (ITNs) and vector control were critical to success, accounting for approximately 68% and 78% of the progress made, respectively (Maskin *et al.*, 2019). However, in recent years, progress has stalled and, in some situations, reversed (WHO, 2020). Several factors, including widespread and increasing insecticide resistance of pyrethroid-based vector control with significantly higher costs of repurposed insecticides to address resistance, the emergence of artemisinin partial resistance, and insufficient funding for malaria control and elimination, have all contributed to this trend (Kafy *et al.*, 2017; WHO, 2021).

Malaria is a major public health problem in Ethiopia, where approximately 75% of the country's land mass has favorable conditions for malaria transmission and approximately 68% of the population is at risk (Girum *et al.*, 2019).

Ethiopia is one of the nations that have implemented the revised malaria control strategies. The most crucial components of the malaria prevention and control strategy are IRS and LLINs (Yewhalaw and Kweka, 2016). Furthermore, Ethiopia is using rapid RDTs at the community level and adapting artemisinin-based combination treatments (ACTs) (Feleke *et al.*, 2021).

Ethiopia has achieved remarkable reductions in malaria burden by implementing these strategies, with declines in mortality and incidence of 96% and 89%, respectively, between 1990 and 2015. However, malaria remains a significant health issue in Ethiopia, where only 25% of the population lives in malaria-free areas (Deribew *et al.*, 2017).

Loka Abaya District is a malaria-endemic area with a long history of malaria intervention strategies in Ethiopia. Over the last few years, malaria treatment and control measures have resulted in a significant decrease in disease occurrence in the study area. However, in recent years there has been a tendency for the resurgence of the disease despite significant advances in malaria control, the disease continues to be a public health concern in the district. According to the 2021 Woreda Health Office Report, 12,386 people were screened for malaria in various health facilities, with 3,266 (26.4%) testing positive for malaria infection (Loka Abaya Woreda Health Office Annual report, 2021). This highlights the burden of malaria in the study area and suggests the need for systematic investigation of the problem to design and implement evidence-based malaria prevention and control strategies. Current knowledge on malaria prevalence, its associated factors, and the proportion of *Plasmodium* species in the specific study area community is limited. As a result, the purpose of this study was to determine the prevalence of malaria infection, and the proportion of *Plasmodium* species and to identify the risk factors for disease transmission in the study area, Loka Abaya, Sidama, Southern Ethiopia.

2. LITERATURE REVIEW

2.1. Prevalence of Malaria

Throughout human history, malaria has remained a cause of untold morbidity and mortality (Nosten *et al.*, 2022). The 2021 World Malaria Report, published by the World Health Organization (WHO), estimates there were 1.7 billion cases of malaria worldwide and 10.6 million malaria deaths were averted in the period 2000 to 2020. Most of the cases (82% of them) and deaths (95% of them) were in the WHO African Region, followed by the WHO South-East Asia Region (cases 10% and deaths 2%) (WHO, 2021).

A community-based cross-sectional studies in Kano State, Nigeria, revealed that the prevalence of malaria infection was 60.6%, with all infections being *P. falciparum* (Dawaki *et al.*, 2016) and Mozambique's Sussundenga District showed that 31.6% of 358 participants from 96 households tested positive for *P. falciparum* (Earland *et al.*, 2022).

A cross-sectional study in the Unwana community of Nigeria found that 54.2% testing positive (Odikamnoro *et al.*, 2018). A similar study conducted in Malawi to assess the prevalence of *P. falciparum* among asymptomatic adolescents and adults ages (15-54) by using DNA amplification and genotyping techniques shows 31.1% were PCR-positive for *P. falciparum* (Topazian *et al.*, 2020).

A retrospective study in Woreta, Amhara region, reported that 32.6% were microscopically confirmed to be positive for the disease (Alelign *et al.*, 2018). A similar study conducted in Kombolcha, Ethiopia, shows that 7.52% of the cases were microscopically confirmed malaria from malaria-suspected patients (Gebretsadik *et al.*, 2018).

A cross-sectional study at the Chagni Health Center in Northwest Ethiopia found that 7.3% had malaria infections (Belay *et al.*, 2021). In related studies, conducted at the Hamusit Health Center in Northwest Ethiopia, 61 (29%) of the 210 participants with suspected malaria were found to have *Plasmodium* species infection (Negatu *et al.*, 2022) and the South Gondar Zone, malaria infection was found in 14.7% (Workineh *et al.*, 2021).

A community-based cross-sectional study conducted in Ethiopia, Amhara region, in West

Armachiho district on migrant laborers in agricultural camps showed that 18.4% of people were positive for malaria infections (Aschale *et al.*, 2018). Other similar studies were conducted in North-west Ethiopia in the Dembia district among adults (Fekadu *et al.*, 2018) and pastoral communities of Waghemira Zone, Northeast Ethiopia (Debash *et al.*, 2023); showing that 6.7% and 21.2% respectively.

A cross-sectional study conducted in two North Eastern Region districts of India showed that, from 9118 individuals were screened for malaria using RDTs, of which 6.5% were found to be positive for malaria, and light microscopy was used to screen 8595 of the 9118 samples, and 187 (2.2%) were parasitaemic. A subset of samples (n=3457) from the total screened samples was chosen at random for molecular diagnosis of malaria using PCR, and 384 (11.1%) positive cases were found (Shankar *et al.*, 2021).

A community-based cross-sectional study that was conducted in Ethiopia in twelve villages in Gambella, the Southern Nation Nationalities and People Region (SNNPR), and Afar shows the prevalence of asymptomatic *Plasmodium* carriage (*P. falciparum*, *P. vivax,* and mixed species) was 8.1% as determined by microscopy, while the prevalence as determined using RDT was 9.3% (Goshu *et al.*, 2022). A similar study was conducted among pastoralist communities in Benna Tsemay district, South Omo Zone, Southern Ethiopia to assess the prevalence of malaria and associated factors constituting traditional practices and mosquito net use in a pastoralist district of southern Ethiopia, using a structured and pre-tested questionnaire to collect socio-demographic and risk factor data, as well as using the RDT and blood slides for malaria diagnosis indicates that 6.1% of cases tested positive for malaria (Debo and Kassa, 2016).

A cross-sectional conducted among adults in the East Shewa Zone of Oromia Regional State, Ethiopia showed that 25% had microscopically confirmed malaria parasites (Tadesse *et al.*, 2017). Another similar study carried out in the Yinesa, Andasa, and Robit health centers in the Bahir Dar Zuria district, Northwest Ethiopia, revealed that of the 149 participants, 20 (13.4%) and 19 (12.8%) had *Plasmodium* infection, as determined by RDTs and microscopy, respectively. In total, 22 (14.8%) participants had positive results from at least one of the diagnostic techniques (Dejazmach *et al.*, 2021).

A community-based cross-sectional study conducted among households in Guanga Town, Abaya District, Oromia Regional State, Southern Ethiopia, indicates that, of the 227 study subjects examined in Gunaga Town using data collected from households, study subjects reported an overall prevalence of malaria infection in the study area was 8.3% (Obsie and Gondol, 2021).

An institutional-based cross-sectional study conducted in Lake Tana and surrounding areas of northwest Ethiopia found 24.7% (overall prevalence) of confirmed malaria cases (Adugna *et al.*, 2022). Another similar study conducted in Southwestern Nigeria in urban communities of Ibadan revealed that 300 people participated, with 165 (55.0%) testing positive for *P. falciparum* (Awosolu *et al.*, 2021).

A community-based cross-sectional study conducted among selected kebeles in the Debre Elias district, Amhara region, north-western Ethiopia, to assess the prevalence of symptomatic and asymptomatic malaria using light microscopy of stained blood films and RDT found that the total prevalence of malaria was 5% out of 440 participants (333 asymptomatic and 107 symptomatic) (Abebaw *et al.*, 2022). A similar study conducted in Southwest Ethiopia among the communities of Mizan-Aman town and its catchment area using microscopic examinations of blood films for malaria parasites indicated that 21.1% had malaria parasites (Duguma *et al.*, 2022).

2.2. Proportion of *P. vivax* and *P. falciparum*

Five species of the genus *Plasmodium* parasites can cause malaria in humans and two of these species, *P. falciparum,* and *P. vivax* are posing the greatest threat and accounting for the majority of malaria-related morbidity and mortality. *P. falciparum* is responsible for most cases of severe clinical malaria (Battle and Baird, 2021).

A community-based cross-sectional survey which was conducted in Kano State, Nigeria identified the prevalence of *P. falciparum* infection was 60.6% (Dawaki *et al.*, 2016). A similar study in Mozambique's Sussundenga district also identified a prevalence of 31.6% of *P. falciparum* (Earland *et al.*, 2022).

A study conducted in Dembia district, North-West Ethiopia reported that the dominant *Plasmodium* species was *P. falciparum* 46 (82%), followed by 5 (9%) *P. vivax*, and 5 (9%) mixed infections (*P. falciparum* and *P. vivax*) (Fekadu *et al.*, 2018). Similarly, another study carried out in West Armachiho Amhara region, Ethiopia; also identified a high prevalence of *P. falciparum* (13%), followed by *P. vivax* (1.8%) and 3.6% mixed infection. *P. falciparum* made up 70.4% of the relative *plasmodium* species proportions of positive cases, followed by *P. vivax* at 9.9% and mixed infections at 19.7% (Aschale *et al.*, 2018).

A community-based cross-sectional survey in Benna Tsemay district, South Omo Zone, Southern Ethiopia, found two *Plasmodium* species: 69% *P. falciparum*, 24% *P. vivax*, and 7% mixed infection (Debo and Kassa, 2016). A similar study conducted in Southwest Ethiopia among the communities of Mizan-Aman town and its catchment area discovered two *plasmodium* species, *P. falciparum* (10.7%) and *P .vivax* (9.2%) (Duguma *et al.*, 2022).

An institutional-based cross-sectional study conducted in Lake Tana and surrounding areas of northwest Ethiopia found that *P. falciparum* was responsible for the majority of the infections (72.5%), followed by *P. vivax* (23.7%), and mixed-species (3.8%) (Adugna *et al.*, 2022). Another retrospective study conducted in Kombolcha Health Centre, Ethiopia also showed *P. falciparum* was the most commonly reported species, accounting for 60.2% of cases, while *P. vivax* accounted for 35.5% of cases. Mixed *P. falciparum* and *P. vivax* infections accounted for 4.3% of all infections confirmed cases (Gebretsadik *et al.*, 2018).

A cross-sectional study at the Chagni Health Center in Northwest Ethiopia discovered that the only species found in the study area were *P. falciparum* and *P. vivax*, with *P. falciparum* accounting for 163 (55%), *P. vivax* for 131 (44.3%), and 2 (0.7%) infections that were mixed infections of both species (Belay *et al.*, 2021). A similar study from Hamusit Health Center in Northwest Ethiopia discovered that *P. falciparum* and *P. vivax* were detected in 41 (19.5%) and 10 (4.8%) participants, respectively, and that mixed infection was detected in 10 (4.8%) participants (Negatu *et al.*, 2022).

According to a cross-sectional study conducted among adults in the East Shewa Zone of Oromia Regional State, Ethiopia, the dominant *Plasmodium* species were *P. vivax* 111 (54%), followed by *P. falciparum* 92 (45%), and the remaining one (0.5%) showed mixed infections of *P.*

falciparum and *P. vivax* (Tadesse *et al.*, 2017). Another similar study from the Bahir Dar Zuria district in Northwest Ethiopia found that the prevalence of *P. falciparum* and *P. vivax* was 3.4% and 10.1%, respectively, while that of mixed infection was 1.3% (Dejazmach *et al.*, 2021).

A community-based cross-sectional study conducted among selected kebeles in the Debre Elias district, Amhara region, North-Western Ethiopia identified two *Plasmodium* species. According to this study, the relative proportions of *P. falciparum* and *P. vivax* in parasitologically confirmed asymptomatic malaria cases were 57.1% and 42.9%, respectively. *P. falciparum* accounted for 62.5% of the symptomatic individuals found in the survey, while *P. vivax* accounted for the remaining 37.5%, as confirmed by RDT or microscopy (Abebaw *et al.*, 2022).

2.3. Associated Risk Factors for the Transmission of Malaria

Malaria infection occurrence is influenced by socio-demographic, behavioral, socioeconomic, and environmental factors in a specific geographic area. These factors influence malaria risk status, susceptibility, social interaction, and behaviors, thereby promoting disease occurrence by creating a favorable environment for malaria vectors to thrive (Degarege *et al.*, 2019; Bello, 2021).

Different studies showed that socio-demographic factors were significantly associated with malaria infection, like age. The study from Mozambique showed that the highest malaria prevalence (26.4%) was among children aged 5–10 years old (Earland *et al.*, 2022). Another study from North-west Ethiopia at Dembia district (Fekadu *et al.*, 2018), a study from Malawi (Topazian *et al.*, 2020), a cross-sectional study from Chagni Health Center, Northwest Ethiopia (Belay *et al.*, 2021) and also a study from East Shewa, Ethiopia (Tadesse *et al.*, 2017) showed the significant association between age group and malaria infection. Contrary to these studies some studies, a study from West Armachiho District, Northwest Ethiopia (Aschale *et al.*, 2018) and a study from Benna Tsemay district of the pastoralist community of Southern Ethiopia (Debo and Kassa, 2016) found no association between malaria infection and age group.

Gender has been linked to malaria infection in some studies; one from Nigeria's Ibadan community found that males (60.2%) had a higher prevalence than females (50.9%) (Awosolu *et al.*, 2021). Another institution-based study from North West Ethiopia (Adugna *et al.*, 2022), also discovered a link between gender and malaria as well.

Several studies have discovered a link between education level and malaria infection. A study from the Amhara Region, West Armachiho District (Aschale *et al.*, 2018), Lake Tana and its surrounding area (Adugna *et al.*, 2022), the Nigerian community of Ibadan (Earland *et al.*, 2022) and Guanga town, Abaya District, Oromia Regional State, Southern Ethiopia (Obsie and Gondol, 2021).

Several studies have found an association between malaria infection and socioeconomic factors such as housing conditions, monthly income, availability and number of ITNs per HH, chemical spray, and access to health care. A study conducted in Ethiopia in twelve villages of Gambella, SNNPR, and Afar, for example, found that the prevalence of asymptomatic malaria infection ranges from 8.1% to 8.4% among people living in traditional floor/wall/roof houses, whereas it ranges from 2.0% to 4.6% among people living in modern floor/wall/roof houses (Goshu *et al.*, 2022).

Low monthly income was also significantly associated with malaria infection (Degarege *et al.*, 2019; Rudasingwa and Cho, 2020). Bed-net availability was also significantly associated with malaria infection (Abebaw *et al.*, 2022; Duguma *et al.*, 2022).

Different studies revealed that the presence or absence of malaria infections is influenced by environmental factors such as the geographic location and type of human habitation about the presence of stagnant water for mosquito breeding. One study from the Dembia district of northwest Ethiopia found that people who lived near stagnant water were significantly more likely to contract malaria than people who did not (Fekadu *et al.*, 2018). Another study from Guanga, Abaya District, Oromia Regional State, Southern Ethiopia showed that people with stagnant water in their compounds had a nearly seven-fold higher prevalence of malaria (Obsie and Gondol, 2021). And also study from Mizan-Aman town, Southwest Ethiopia found that individuals who live near stagnant water and in hotter climates were found to be more

susceptible to malaria infection (Duguma *et al.*, 2022). And also; a household with no toilet facility was significantly associated with increased malaria infection (Sharma *et al.*, 2021).

Some studies also discovered an association between malaria infection and sleeping in the same house with the cattle. A study from Lake Tana and surrounding areas in northwest Ethiopia (Adugna *et al.*, 2022) as well as one from the Ethiopian lowlands (Goshu *et al.*, 2022), found that spending nights with cattle in the same house was significantly associated with increased malaria infection.

Several studies have also found a link between chemical spraying and malaria infection. A study from Guanga town, Abaya District, Oromia Regional State, Southern Ethiopia, found that walls that had not been sprayed in the previous 12 months were more than twice as likely to contract malaria morbidity as sprayed walls (Obsie and Gondol, 2021). Another study from Mizan-Aman town and its catchment area in Southwest Ethiopia found that the homes of two-thirds of those positive cases had not been sprayed with insecticide chemicals (Duguma *et al.*, 2022).

The likelihood that a person will contract malaria is primarily determined by how his or her behavior affects the level of human-vector contact (CDC, 2020a). A study from Lake Tana and surrounding areas in northwest Ethiopia (Adugna *et al.*, 2022), as well as one from the Ethiopian lowlands (Goshu *et al.*, 2022), found that sleeping outdoors has a strong influence on malaria transmission.

Several studies, including those from the Benna Tsemay district in Southern Ethiopia (Debo and Kassa, 2016), West Armachiho district in Northwestern Ethiopia (Aschale *et al.*, 2018), Dembia district in Northwestern Ethiopia (Fekadu *et al.*, 2018), Guanga from the Abaya district in Southern Ethiopia's Oromia Regional State(Obsie and Gondol, 2021), and Mizan-Aman Town and its catchment area (Duguma *et al.*, 2022) showed that there was a strong correlation between malaria infection and not using bed nets.

The success of intervention programs can be ensured by adopting a targeted allocation of a malaria intervention strategy to ensure that interventions reach the population that is at a relatively higher risk of contracting the disease (Tizifa *et al.*, 2018).

Malaria risk status varies by geographic region (Cella *et al.*, 2019; Fouque and Reeder, 2019) and it is dependent on current economic, demographic, behavioral, and environmental risk variables. However, to design a focused malaria intervention, it is important to have a solid understanding of the socio-demographic, behavioral, and environmental risk factors that influence the likelihood that malaria will occur (Dawaki *et al.*, 2016). The socio-demographic, socioeconomic, behavioral, and environmental risk factors that affect malaria's prevalence and transmission patterns were assessed by the study.

2.3.1. Conceptual frame work

Malaria infection is affected by different factors; like socio-demographic, socioeconomic, individual, and environmental factors

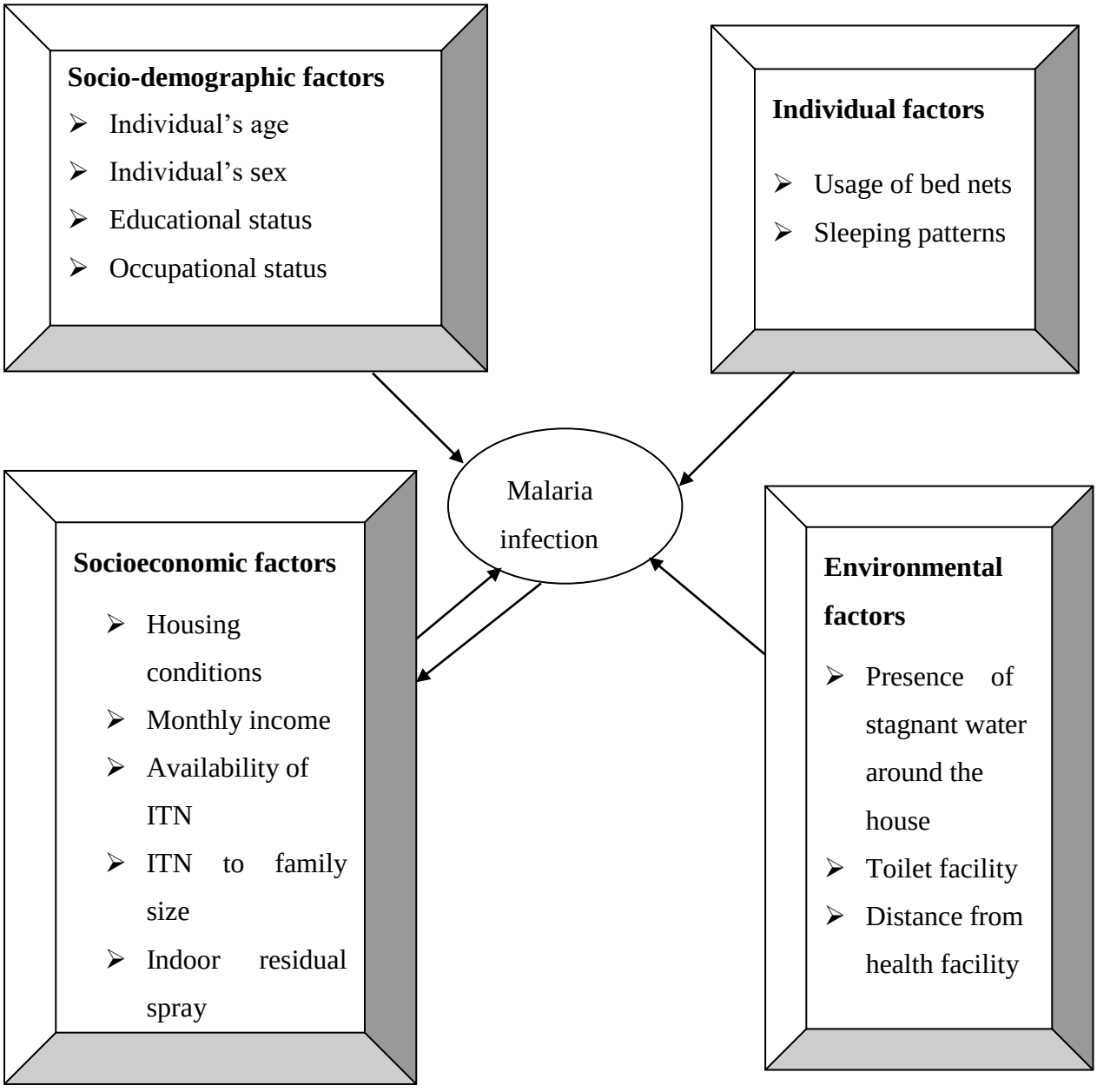

Figure 1: Conceptual framework for determining the prevalence of malaria and its associated factors in the Loka Abaya District, Sidama, Southern Ethiopia, in 2023. Adopted from different literatures (Fekadu *et al.*, 2018; Degarege *et al.*, 2019; Awosolu *et al.*, 2021; Obsie and Gondol, 2021; Goshu *et al.*, 2022).

1.3. Significance of the Study

It is obvious that the global malaria situation is the sum of the conditions in each country, and that each country's situation is made up of its regional and local conditions at each level. Planning national health services, determining future priorities, and evaluating progress toward goals all depend on accurate assessments of the malaria burden level and its associated factors.

The findings of this study will assist local health facilities and concerned health offices in an understanding of the malaria burden and proportion of *Plasmodium* species in the study area, Loka Abaya District, as well as in planning well-organized malaria prevention and control programs and/or scaling up the existing malaria prevention and control mechanisms. Identifying the proportion of *Plasmodium* species in the study area is critical for developing management strategies. Additionally, the study will provide scientific evidence that will be important in advancing current knowledge on the malaria situation in the study area. Furthermore, the study will be used as up-to-date information for those who need to conduct further investigations in the area.

3. OBJECTIVES OF THE STUDY

3.1. General Objective

To determine the prevalence of malaria, its associated factors, and the proportion of *Plasmodium* species in the community of Loka Abaya District, Sidama, Southern Ethiopia in 2023.

3.2. Specific Objectives

1. To determine the prevalence of malaria in the community of Loka Abaya District
2. To determine the proportion of *Plasmodium* species in the study area
3. To identify factors associated with malaria infection

4. MATERIALS AND METHODS

4.1. Study area and Period

The study was conducted in Loka Abaya District, Sidama Regional State; Southern Ethiopia from April through May 2023. The District is one of the 36 Districts found in the Sidama region, Ethiopia. The place is located at a distance of 344km toward South East of the capital of Ethiopia, Addis Ababa, and 69 km from the regional capital, Hawassa. The District is located in the great rift valley of Ethiopia at 6° 42´- 6º 83´ N and 38° 01´- 38° 36´E the total area is about 878km^2. The study area is characterized by a bi-modal type of rainfall in which the short rainy season occurs from March to May, whilst the main rainy season occurs from June to September. Mean annual rainfall varies from 700 mm to 1877 mm and the mean annual temperature ranges from 26°C to 35°C. The area is also characterized by erratic rainfall, moisture stress, and high temperatures during the dry season. The altitude ranges from 1001 to 2000 meters above sea level.

The population's livelihood is based on subsistence mixed farming. Enset (*E. ventricosum*) is one of the major crops grown in the district. Based on the census conducted in 2007, Loka Abaya District has a total population of 110,917, of which 56,566 are men and 54,351 are women. Administratively, Loka Abaya District is organized in 24 kebeles and 2 municipal towns, all kebeles are malarious. The number of households in Woreda was 22,917. Loka Abaya is located west of the Wolayta zone, North of Darara, North East of Dale, South of Oromiya, East of Aleta Chuko, and South West of Lake Abaya. Loka Abaya Woreda has 1 Primary Hospital, 5 health centers, 24 health posts, and 3 private clinics.

Warmer temperatures in the study area will alter the growth cycle of the parasite in the mosquito, allowing it to develop faster, increasing transmission and thus impacting disease burden at lower altitudes where malaria is already a problem. As a result, the District was chosen based on the previously mentioned specific climatic conditions, reports indicating that malaria remains a health problem for the community of study area, and the fact that no study has been conducted to determine the burden of malaria in the District.

Based on the local seasonality of malaria transmission, a specific period for the study was selected. Even though malaria is endemic throughout the year due to the presence of permanent rivers, lakes, and ponds, there are two seasonal malaria transmission peaks in the study area: from April to May (minor transmission) and from September to December (major transmission).

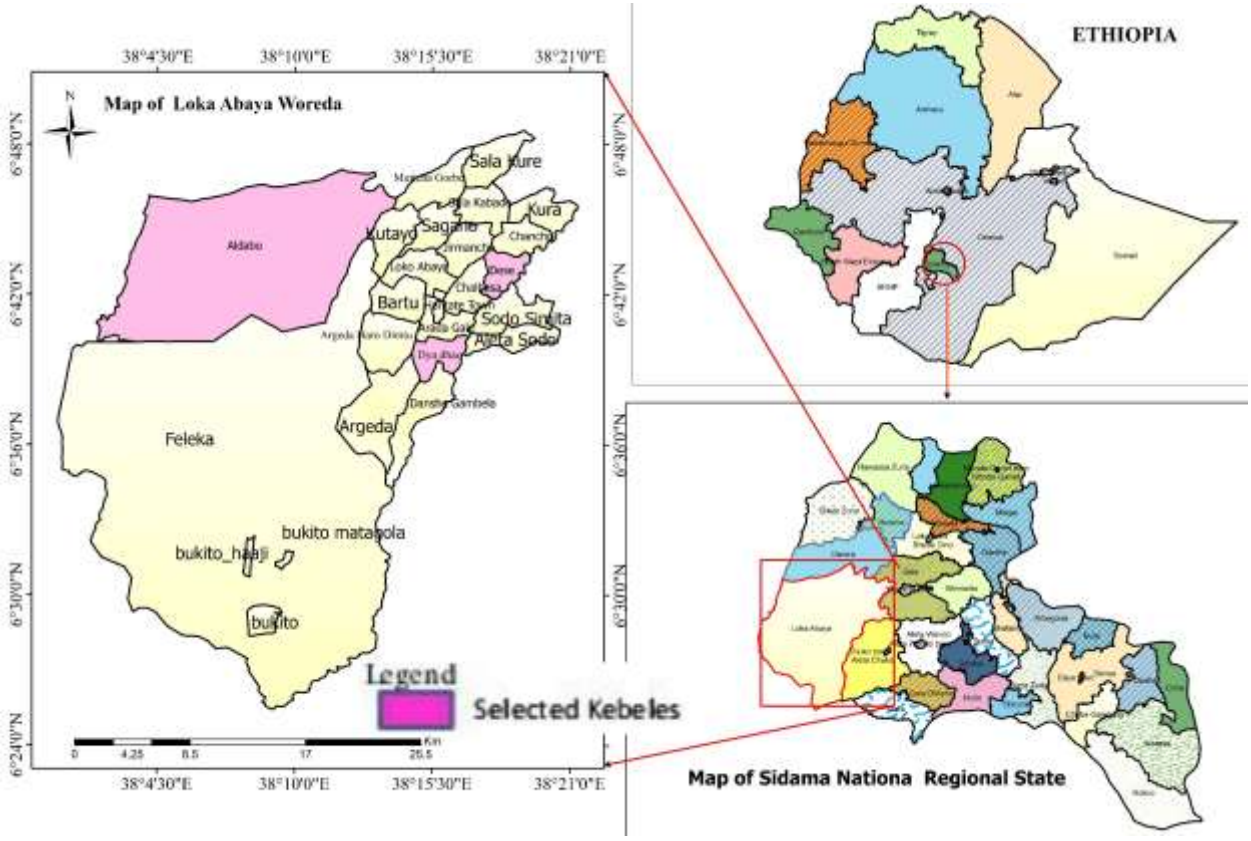

Figure 2: Map of Loka Abaya District, Sidama Region, Southern Ethiopia (Prepared by using ARC-GIS/map software)

4.2. Study Design

A community-based cross-sectional study was conducted among Loka Abaya District communities

4.3. Population

4.3.1. Source Population

The study's source population was all the community members of the Loka Abaya District.

4.3.2. Study Population

The study populations were all age groups and both genders that live in the selected kebeles and were available during the data collection period.

4.3.3. Study Unit

Randomly selected individuals from selected households were the study unit.

3.4. Sample Size and Sampling Technique

3.4.1. Sample Size Determination

The sample size required for this study was calculated by using the Epi Info™ version 7.2.5.0 statistical program. The sample size was determined using a single population proportion formula with the assumption of a 95% confidence level (CI), and a 5% margin of error, taking the expected malaria prevalence of 21.1% from the study conducted in the community of Mizan-Aman town and its catchment area in Southwest Ethiopia (Duguma *et al.*, 2022) and design effect (DE) of 1.5. Then the calculated sample size (n) was 384. By taking a 10% non-response rate, the total sample size was 422.

3.4.2. Sampling Technique

The size of the representative sample was determined using a systematic random sampling method. A lottery method was used to select three of the ten higher malarious kebeles (Dese, Doya Doa, and Aldabo). The most recent demographic registrations of households available at the local kebeles administrations were used to calculate the proportional sample size for each selected kebeles and it was also used as a sample frame. According to the most recent household demographic registrations, Dese has 650 households, Doya Dao has 913 households, and Aldabo has 1,715 households. The estimated sample size was proportionally allocated to the selected three kebeles based on the number of households. At every 8^{th} interval, 83 households from Dese, 118 households from Doya Dao, and 221 households from Aldabo were chosen. Finally, one of the selected household members was chosen at random using lottery methods. If the chosen household member was not present, a revisit was made after asking when the person would be there.

K = N/n

= 3,278/422

= 7.76 ~ 8 i.e. every 8th household was selected

Where K = the interval on which the household was chosen

N = Total number of households in selected kebeles

n = Sample size

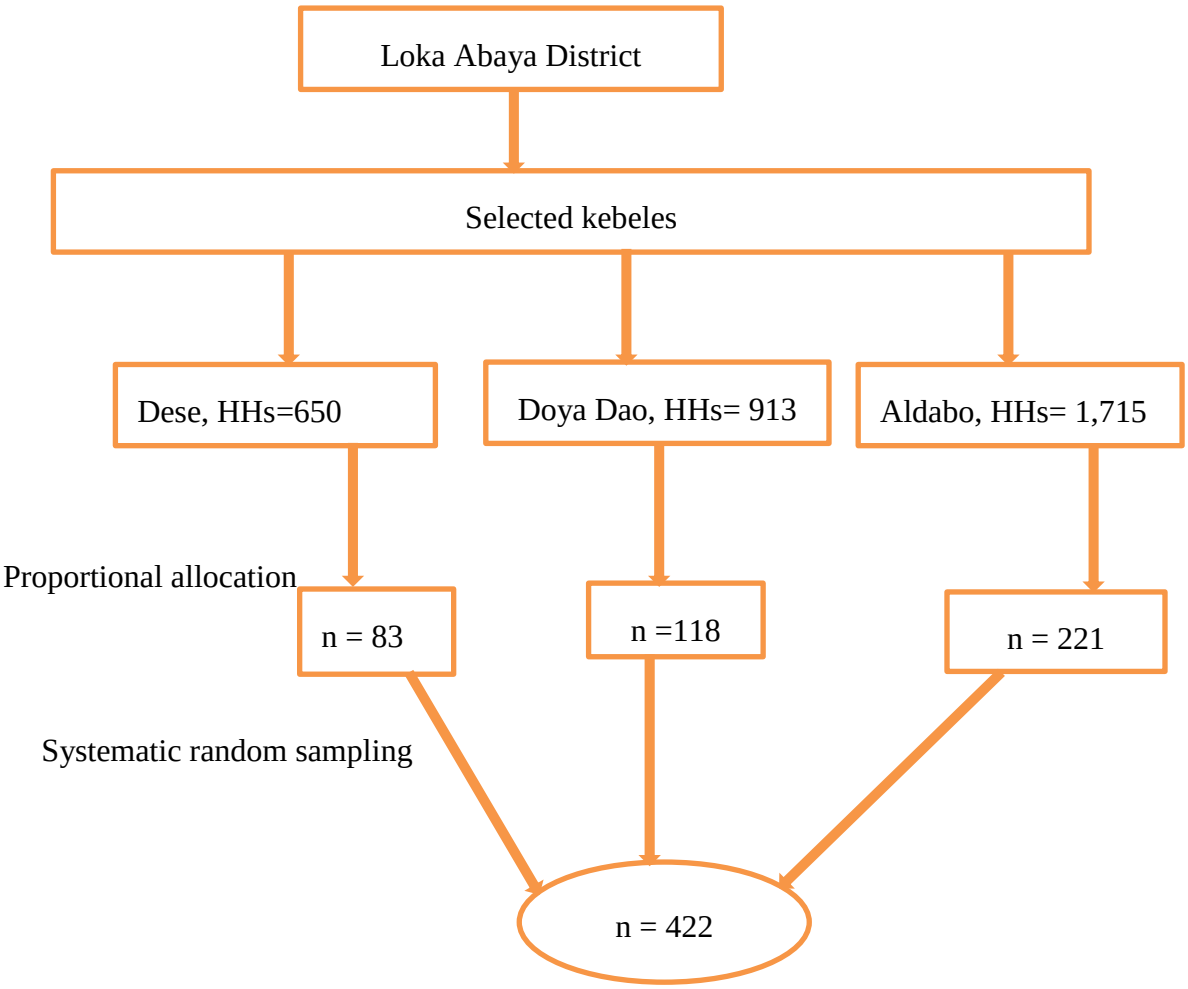

Figure 3: Schematic presentation of the sampling procedure to determine the prevalence and associated risk factors of malaria in the Loka Abaya District

3.5. Study Variables

3.5.1. Dependent Variable

- Malaria infection

3.5.2. Independent Variables

- Age
- Sex
- Educational status
- Occupational status
- Toilet facility
- The presence of stagnant water around the house
- Availability of bed net
- Number of bed nets per family size
- Usage of bed net
- Sleeping patterns
- Indoor residual spray
- Housing condition
- Distance from health facility

3.6. Inclusion and Exclusion Criteria

3.6.1. Inclusion Criteria

All individuals with and without signs and symptoms of malaria who were available during the study period and willing to take part in the study were included in the study.

3.6.2. Exclusion Criteria

Critically ill patients and individuals with mental health problems, as well as individuals who were taking anti-malarial therapy during the data collection period or who had been treated with anti-malarial drugs within the past month before enrollment and short time visitors (those who lived 6 month or less in the selected) were excluded from the study.

4.5. Data Collection Tools and Procedures

4.5.1. Data Collection Process

Healthcare workers collected data after two-day training on the study's objectives and how to obtain informed consent from study participants.

Socio-demographic and other associated factors were collected through a face-to-face interview and visual observation using a pre-tested structured questionnaire (modified from a malaria indicator survey household questionnaire) and checklist Appendix 3. The questionnaire was written in English first and then translated into the local language (Sidamic language) by language experts and finally returned to the original language. If the selected study participants were infants or children, guardians/caregivers/parents were interviewed instead. An observation checklist was used to collect data on the availability, housing conditions, and the presence of stagnant water around houses. A senior health officer examined body temperature and other clinical manifestations to identify symptomatic and asymptomatic individuals. This examination took place following the selection of individuals from households. The data collection process was supervised and assisted by two supervisors.

4.5.2. Blood Sample Collection

Following consent and assent (for the age group of 12-17 years) and enrollment, trained laboratory technicians collected capillary blood samples from each participant using a disposable sterile lancet via a finger prick (a heel prick or big toe for young children) following standard operating procedure (SOP) (FMoH, 2018). Appendix1.A

Following the removal of the first drop, blood samples were used to run malaria RDTs on the spot (using First Response® Malaria Ag. *P.f. / P.v.* Card test, which has 100% sensitivity and specificity, and can specifically detect both *P. falciparum* and *P. vivax* species; and is being supplied by the Ethiopian Ministry of Health to health posts), and to prepare thick and thin blood films on the same slide for each participant and labeled with a unique code. The thin blood smear was fixed by carefully dropping methanol (100% or absolute methanol) with a Pasteur pipette immediately after drying. By placing the slides on a flat surface, the methanol-fixed thin smears were allowed to dry completely in the air. The prepared blood smears were transported to a

nearby health facility (Hantate Primary Hospital) in a slide box for Giemsa staining and microscopic examination.

4.5.3. Blood Film Examinations

Two experienced medical laboratory technologists performed microscopic examinations of blood films. After air drying, the smears were stained with a 10% Giemsa solution for 10 minutes. Following the standard WHO malaria microscopy quality assurance manual (WHO, 2016), the stained smears were examined under a light microscope with an oil immersion (100×) objective to detect the presence of malaria parasites. The results were classified qualitatively as either negative (no malaria parasite seen), positive for specific *Plasmodium* species, or mixed infection. Before reporting a negative result, at least 200 high-power fields (100× objectives) were examined. Appendix1. B-D

4.6. Data Analysis and Interpretation

Socio-demographic and laboratory data collected from each study participant was entered and cleaned using Epi-data Manager version 4.6 and analyzed using the Statistical Package for Social Sciences (SPSS) software version 26 (IBM Corporation, Armonk, NY, USA). Descriptive summaries were used to describe the study variables, and summaries were presented in terms of counts and percentages. Bivariate and multivariable logistic regression results were used to assess the association between the dependent and independent variables. Variables with p-value less than 0.25 in biviaviate anaylsis entered ino multivariable analysis. An adjusted odds ratio (AOR) with 95% CI was used and s tatistical significance was defined at $p < 0.05$.

4.7. Data Quality Control Measures

Both data collectors and supervisors were trained for three days on how to approach study subjects and how to collect both socio-demographic data and blood samples. Before the actual data collection, 5% of the questionnaire was subjected to a pre-test in the Segeno kebele, which is one of the kebeles in the district and was not included in the main study.

Microscopic examination of blood films was done by medical laboratory technologists who did not perform the RDTs test on the spot to prevent bias that may come from knowing the RDTs result.

The trained supervisors and the principal investigator closely followed the daily completeness and appropriateness of the data collection process.

To ensure a reliable result, the quality of the Giemsa stain was checked by using known negative and positive blood smears and the RDT kits were checked for expiry dates. Slides also were rechecked by two experienced blinded laboratory technologists.

All the test procedures and the interpretation of results were accomplished based on SOP.

External quality control was performed on 10% of the blood film slides at Hawassa University Comprehensive Specialized Hospital, Medical Laboratory Department, and Quality Control Case Team, and there were no discrepancies in the results of the slides.

To maintain the quality of the generated data, it was checked again for completeness and cleanliness before starting the analysis.

4.8. Ethical Clearance

Ethical clearance was obtained from the Ethical Review Board of the College of Medicine and Health Sciences, Hawassa University on the date 13/03/2023 with a Ref. No: IRB/204/15. Permission letters were obtained from the Loka Abaya Woreda Health Office and selected kebeles administrations. The informed written consent and assent (for the age group of 12-17 years) were obtained from all study participants before data collection. Participation in the study was based on the willingness of the participants. And also, risks, discomfort, procedures, benefits, incentives, and issues of confidentiality and safety in the study were clearly explained to study participants. All malaria-positive cases were carefully treated according to the national malaria guidelines in collaboration with the Loka Abaya Woreda Health Bureau and nearby health facilities.

4.9. Operational definitions

Condition of ITN: Classified based its physical appearance as valid (no holes), holes that a torch and dirty

Symptomatic malaria: The presence of malaria-related symptoms (fever - i.e., axillary temperature ≥37.5°C, chills, headache, vomiting, joint pain, loss of appetite, sweating, loss of energy and convulsions) within the past 2 days and at the time of examination and the presence of malaria parasites in blood (Zhou *et al.*, 2016).

Asymptomatic malaria: The absence of malaria-related symptoms (fever - i.e., axillary temperature ≤37.5°C, chills, headache, vomiting, joint pain, loss of appetite, sweating, loss of energy, and convulsions) in the preceding two days and at the time of the survey, as well as the presence of malaria parasites in the blood (Nega *et al.*, 2015).

The monthly income of the participants was classified as low (less than 1,000 ETB), medium (1001 to 2,575), and high (2,576 and above) (Fikrie *et al.*, 2021).

5. RESULTS

5.1. Socio-demographic characteristics of participants

The study included 419 individuals, with a response rate of 99%. Of the total respondents, 233 (56.6%), were males, while 186 (44.4%) were females. The participants' median age was 25 years, with an interquartile range (IQR) of 26 (14 - 40). Children (≤14 years) accounted for 27.5% and the majority of the participants (79.5%) had a family size of 4-7 (Table 1).

Table 1: Socio-demographic/economic characteristics of participants in the communities of Loka Abaya district, Sidama, Southern Ethiopia, from April to May 2023

Characteristics	Categories	Frequency	Percent
Sex	Male	233	56.6
	Female	186	44.4
Age group in year/s	<5	33	7.9
	5 – 14	82	19.6
	15 – 24	87	20.8
	25 – 34	74	17.7
	35 – 44	53	12.6
	45 – 55	43	10.3
	>55	47	11.2
Marital status	Married	189	45.1
	Single	209	49.9
	Widowed	14	3.3
	Divorced	7	1.7
Educational status	No formal education	112	26.7
	Primary education	227	54.2
	Secondary education and	80	19.1

	above		
Occupation status	Farmer	142	33.9
	Housewife	57	13.6
	Government employee	16	3.8
	Merchant	39	9.3
	Student	156	37.2
	Daily worker	9	2.1
Family size	<3	64	15.3
	4 – 7	333	79.5
	>7	22	5.3
Monthly income (Ethiopian Birr)	Low (≤1000)	112	26.7
	Medium (1001-2575)	240	57.3
	High (≥2576)	67	16.0
Source of income	Agriculture	374	46.9
	Livestock	359	45.0
	Monthly salary	16	2.0
	Trade	40	5.0
	Daily labor work	9	1.1

5.2. Respondent's Housing Condition

Corrugated roofs and thatched roofs accounted for 157 (37.5%) and 262 (62.5%) of the total houses visited, respectively. One hundred forty-two (33.9%) of the houses had at least one separate bedroom. One hundred forty-three (34.1%) have a separate kitchen. In this study, each household was asked if their house had been sprayed with IRS in the previous 12 months, but they responded that none of their houses had been sprayed during the stated period (Table 2).

Table 2: Housing condition of the communities of Loka Abaya district, Sidama, Southern Ethiopia, from April to May 2023

Variables	Categories	Frequency	Proportion (%)
Type of the house	Corrugated roof	157	37.5
	Thatched roof	262	62.5
Separate bedrooms	Yes	142	33.9
	No	277	66.1
Separate kitchen	Yes	143	34.1
	No	276	65.9
Having window	Yes	199	47.5
	No	220	52.5
Having screening	Yes	23	5.5
	No	396	94.5
Surface of walls	Very smooth	43	10.3
	Smooth	127	30.3
	Rough	211	50.4
	Very rough with a lot of cracks	38	9.1
Openings that allow the entry of mosquitoes	Yes	346	82.6
	No	73	17.4
Having toilet	Yes	397	94.7
	No	22	5.3
Share the house with domestic animals	Yes	307	73.3
	No	112	26.7
Presence of stagnant water	Yes	161	38.4
	No	258	61.6
Reason to not spray IRS	No service from the government	411	98.1
	Don’t know	8	1.9

Abbreviation: IRS - indoor residual spray

5.3 Availability and Utilization of ITN

A total of 334 (79.7%) of the households own at least an ITN, and they were able to show the ITN during the observation of the household's ITN. Eighty-five (20.3%) of households did not have an ITN. The average number of ITNs per household among those with at least one ITN was 2.13, with a range of 1-6 ITNs. One hundred eighty-six (55.7%) households had less than 0.5 ITN per person, implying that there was less than one ITN for two family members to use jointly, whereas 148 (44.3%) households had an ITN of 0.5 or higher per person, implying that there was more than one or higher ITN for two family members to share (Table 3).

Table 3: The availability and utilization of ITN among communities in Loka Abaya district, Sidama, Southern Ethiopia, from April to May 2023

Variables	Categories	Frequency	Percent
ITN availability	Yes	334	79.7
(n = 419)	No	85	20.3
Condition of ITN	Valid Good (no holes)	184	55.1
(n = 334)	Holes that fit a torch	57	17.1
	Dirty	93	27.8
Source of the ITN	Freely from the government	326	97.6
(n = 334)	Self-purchased	8	2.4
Where was the ITN found?	Hanging lose oversleeping place	197	59.0
(n = 334)	Hanging and folded up and tied	19	5.7
	Not hanging, but not stored	85	25.4
	Stored away unpacked	21	6.3
	Still in the package	12	3.6
Anyone who used ITN last night	Yes	247	58.9
(n = 419)	No	172	41.1
Who used ITN the night before	Children <5 year	187	35.7
	Children 5 -10 year	156	29.8
	Wife and husband	51	9.7

	Other adult family member	130	24.8
ITN utilization (n = 419)	Every night	157	37.5
	Most of the nights	106	25.3
	Occasionally	100	23.9
	Never use	56	13.4
Has this ITN ever been washed?	Yes	144	43.1
(n = 334)	No	190	56.9
What was used to wash the ITN?	Water and bar soap	126	87.5
(n = 144)	Water only	18	12.5
Where was the ITN dried	Outside in the shade	33	22.9
(n = 144)	Outside in the sun	111	77.1
Tack the net (n = 334)	Tack the net properly	224	67.1
	Unable to tack the net properly	110	32.9

Abbreviation: ITN - insecticide-treated nets

5.4. Clinical Data

Of the total 419 study participants, 289 (69.0%) were asymptomatic and the remaining 130 (31.0%) were symptomatic. A total of 164 (72.3%) people had an axillary temperature of 37.5° C or higher. One hundred thirteen (31.0%) participants had a fever, while 72 (17.2%) and 58 (13.8%) had sweating and headaches, respectively (Table 4).

Table 4: Clinical data of study participants among communities of Loka Abaya district, Sidama, Southern Ethiopia, from April to May 2023

Variables	Categories	Frequency	Proportion (%)
History of fever within in past 2 days	Yes	130	31.0
	No	303	69.0
The auxiliary temperature at the time of data collection	<37.5	303	72.3
	≥37.5	116	27.7
Loss of energy	Yes	41	9.8
	No	378	90.2
Vomiting	Yes	8	1.9
	No	411	98.1
Sweating	Yes	72	17.2
	No	347	82.8
Headache	Yes	58	13.8
	No	361	86.2
Loss of appetite	Yes	54	12.9
	No	365	87.1
Chills	Yes	56	13.4
	No	363	86.6
Convulsions	Yes	16	3.8
	No	403	96.2

5.5. Prevalence of Malaria

RDTs and microscopy confirmed *Plasmodium* infection in 61 (14.3%) and 55 (13.3%) of the 419 participants, respectively. In total, 61 (14.6%, 95% CI: 11.0-18.0) of the participants were found to be positive by at least one of the diagnostic methods; all blood films positive by microscopic examination were also positive by RDTs, but from 14.6% (61) positive by RDT only 13.3% (55) positive by microscopic examination of blood films.

The relative proportions of *P. falciparum* and *P. vivax* infection were 36 (59.0%, 95% CI: 46.3-71.7) and 22 (36.1%, 95% CI: 23.7-48.5), respectively, while the proportion of mixed (*P. falciparum* and *P. vivax*) infection was 3 (4.9%, 95% CI: -0.7-10.5) (Fig. 4).

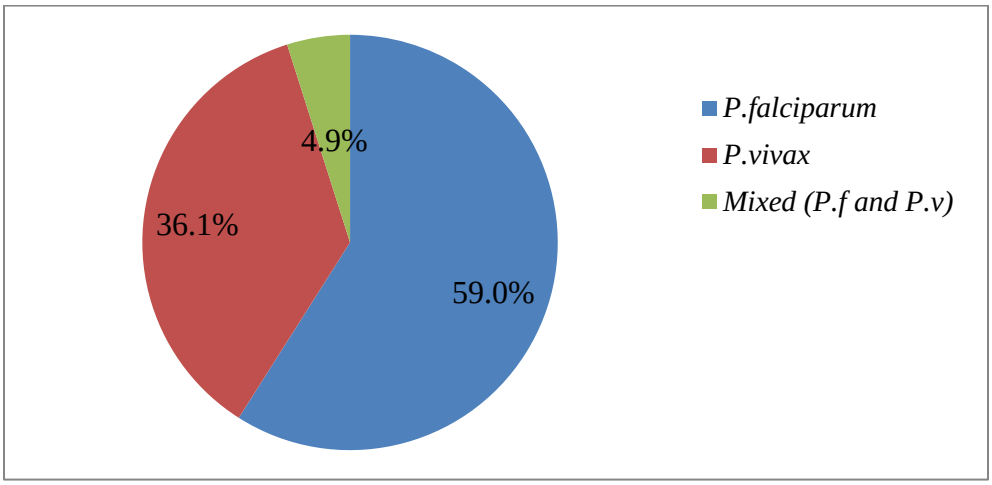

Figure 4: The proportion of *Plasmodium* species in the community of Loka Abaya, Southern Ethiopia 2023

5.5.1. Proportion of malaria among symptomatic and asymptomatic individuals

The proportion of malaria infection among symptomatic and asymptomatic individuals was 40 (30.7%) and 21 (7.3%%) respectively, as determined by RDT and/or light microscopy (Table 5).

Table 5: Proportion of asymptomatic and symptomatic malaria, Loka Abaya district; Sidama, Southern Ethiopia, April to May 2023

Participants	**Negative**		**Positive**	
	Frequency	Percent	Frequency	Percent
Symptomatic	130	31.0	40	30.7
Asymptomatic	289	69.0	21	7.3

Abbreviation: RDT - rapid diagnostic test

5.5.2. Distribution of Malaria Infection by Sex and Age Groups of the Participants

The overall prevalence of malaria infection was 61 (14.6%) in this study; of this, 30 (12.8%) were males and 31 (16.6%) were females (Table 6).

Table 6: The distribution of malaria infection with the sex of the participants Loka Abaya district; Sidama, Southern Ethiopia, April to May 2023

Variables	Categories	Frequency	Positive	
			Frequency	Percent
Sex	Male	233	30	12.8
	Female	186	31	16.6
Overall		419	61	14.6

From the overall prevalence of malaria infection, 17 (27.9%) were reported from the age group between 15 and 24, as indicated in Figure 5.

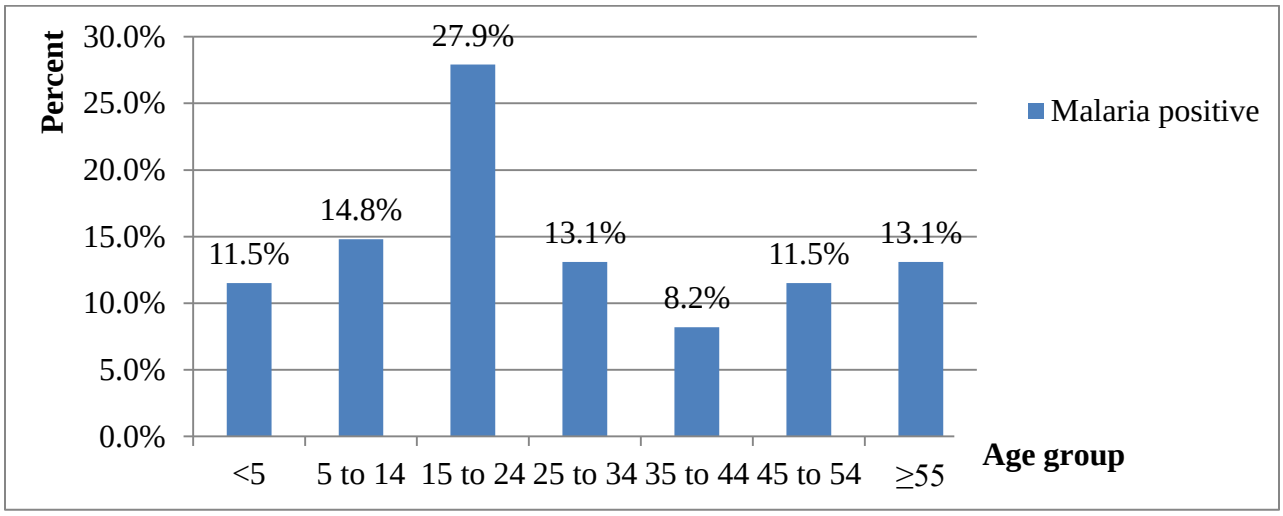

Figure 5: The distribution of malaria infection with the age groups of the participants in Loka Abaya District, Southern Ethiopia 2023

5.5.3. Distribution of Malaria Infection and the *Plasmodium* species in three selected kebeles

Malaria infection was found in 16 (26.2%), 14 (23.0%), and 31 (50.8%) of Doya dao, Dese, and Aldabo kebeles, respectively as indicated in Figure 6.

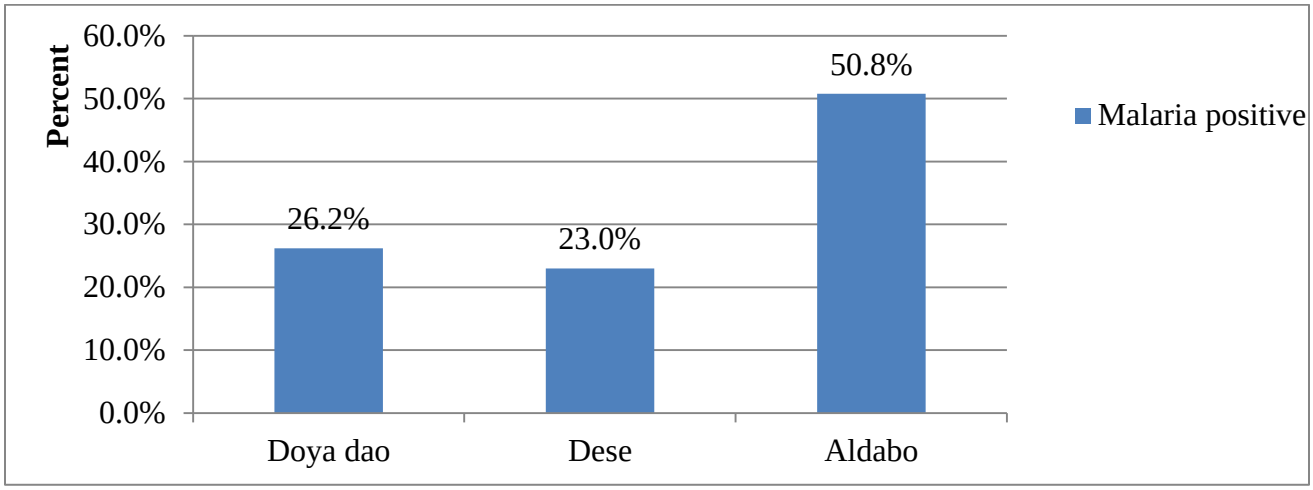

Figure 6: The distribution of malaria infection in three selected kebeles in Loka Abaya District, Southern Ethiopia, 2023

The *Plasmodium* species distribution among three selected kebeles shows, that 29.5% and 19.7% were *P .falciparum* and *P. vivax* respectively from the Aldabo Kebele (Fig.7).

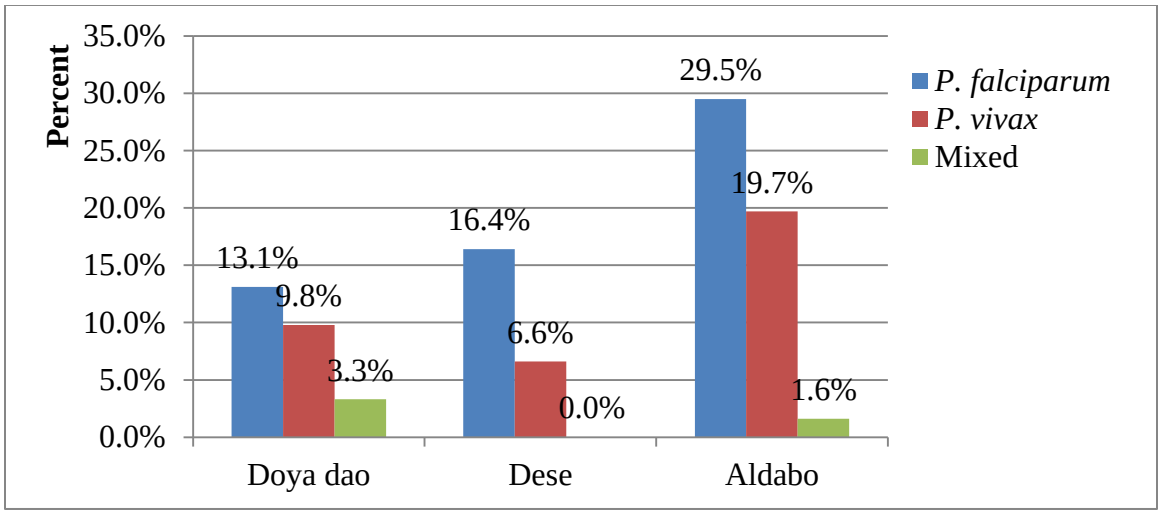

Figure 7: The distribution of *Plasmodium* species in three selected kebeles

5.6. Factors Associated with Malaria Infection

In the bivariate analysis, educational status, monthly income, ITN availability and utility, having a separate kitchen, and the presence of stagnant water around the house were all predictors of malaria infection (Table 7).

In the multivariable analysis malaria infection was nearly threefold higher in those with no formal education compared to those with secondary education and above [(adjusted odds ratio, AOR: 2.56; 95% CI: 1.10 - 5.94)]. Participants with low monthly income were nearly three times more likely to contract malaria than those with high monthly income (AOR: 2.97; 95% CI: 1.07 - 8.25). Similarly, individuals who did not have ITN were nearly three times more likely to contract malaria than those who did (AOR: 2.56; 95% CI: 1.14 - 5.75). The odds of individuals infected with malaria who never used ITN during sleep were nearly three times higher than that of individuals who used ITN every night (AOR: 2.88; 95% CI: 1.13 - 7.32). Individuals with stagnant water around their compounds had a nearly twofold increased prevalence of malaria infection (AOR=2.12, 95% CI: 1.14 - 3.99) (Table 8).

Table 7: Bivariate analysis results for possible factors associated with malaria infection among the communities of Loka Abaya District 2023.

Variables	Malaria infection		COR (95% CI)	P-value
	Positive (%)	Negative (%)		
Educational status				
No formal education	33 (54.1)	79 (22.0)	2.37 (1.34-4.94)	0.022
Primary education	16 (26.2)	211 (59.0)	0.43 (0.19-0.95)	0.038
Secondary and higher education	12 (19.7)	68 (19.0)	1	
Monthly income				
Low	27 (44.3)	85 (23.7)	2.3 (1.0-5.51)	0.051
Medium	26 (42.6)	214 (59.8)	0.89 (0.39-2.08)	0.799
High	8 (13.1)	59 (16.5)	1	
ITN availability				
Yes	37 (60.7)	297 (83.0)	1	
No	24 (39.3)	61 (17.0)	3.16 (1.76-5.66)	<0.001
ITN utilization				
Every night	17 (27.9)	140 (39.1)	1	
Most of the nights	7 (11.5)	99 (27.7)	0.58 (0.23-1.46)	0.248
Occasionally	16 (26.2)	84 (23.5)	1.57 (0.75-3.27)	0.23
Never use	21 (34.4)	35 (9.8)	4.94 (2.36-2.35)	<0.001
Separate kitchen				
Yes	16 (26.2)	127 (35.5)	1	
No	45 (73.8)	231 (64.5)	1.55 (0.84-2.85)	0.162
The presence of stagnant water				
Yes	35 (57.6)	126 (35.2)	2.48 (1.43-4.30)	0.001
No	26 (42.6)	232 (64.8)	1	
Overall	61 (14.6)	358 (85.4)		

Abbreviations: ITN - insecticide-treated nets, CI – confidence interval; COR - crude odds ratio. 1 represents the reference category during analysis.

Table 8: Multivariable analysis results for possible factors associated with malaria infection among the communities of Loka Abaya District 2023.

Variables	Malaria infection		AOR (95% CI)	P-value
	Positive (%)	Negative (%)		
Educational status				
No formal education	33 (54.1)	79 (22.0)	2.56 (1.10-5.94)	0.029*
Primary education	16 (26.2)	211 (59.0)	0.47 (0.20-1.12)	0.88
Secondary and higher education	12 (19.7)	68 (19.0)	1	
Monthly income				
Low	27 (44.3)	85 (23.7)	2.97 (1.07-8.25)	0.037*
Medium	26 (42.6)	214 (59.8)	1.15 (0.43-3.12)	0.77
High	8 (13.1)	59 (16.5)	1	
ITN availability				
Yes	37 (60.7)	297 (83.0)	1	
No	24 (39.3)	61 (17.0)	2.56 (1.14-5.75)	0.023*
ITN utilization				
Every night	17 (27.9)	140 (39.1)	1	
Most of the nights	7 (11.5)	99 (27.7)	0.41 (0.15-1.09)	0.073
Occasionally	16 (26.2)	84 (23.5)	1.23 (0.54-2.83)	0.623
Never use	21 (34.4)	35 (9.8)	2.88 (1.13-7.32)	0.027*
Separate kitchen				
Yes	16 (26.2)	127 (35.5)	1	
No	45 (73.8)	231 (64.5)	1.30 (0.65-2.5)	0.458
The presence of stagnant water				
Yes	35 (57.6)	126 (35.2)	2.12 (1.14-3.99)	0.017*
No	26 (42.6)	232 (64.8)	1	
Overall	61 (14.6)	358 (85.4)		

Abbreviations: AOR, adjusted odds ratio; CI – confidence interval; ITN - insecticide-treated nets; (∗) indicates significance at $p < 0.05$. 1 represents the reference category during analysis.

6. DISCUSSION

According to the findings of this study, the overall prevalence of malaria in the Loka Abaya community was 14.6%. This result was comparable to studies conducted in Ethiopia including the Bahir Dar Zuria district (14.8%) (Dejazmach *et al.*, 2021) and South Gondar Zone (14.7%) (Workineh *et al.*, 2021).

The current study reported a higher prevalence of malaria compared to previous studies conducted in various parts of Ethiopia (Fekadu *et al.*, 2018; Obsie and Gondol, 2021; Goshu *et al.*, 2022; Yhdego *et al.*, 2022). These previous studies reported malaria prevalence rates ranging from 5% to 9.5% in different regions and districts. The possible reasons for the difference in prevalence could be the difference in geographical location, sample size, and locally implemented malaria control programs. The current study area had not been sprayed with insecticide for malaria control in the last consecutive three years before the study, which might have contributed to the higher prevalence.

Higher malaria prevalence rates have been reported from various parts of Ethiopia compared to our study, including 18.4% in West Armachiho District (Aschale *et al.*, 2018), 25.0% in East Shewa Zone (Tadess *et al.*, 2017), 21.1% in Mizan-Aman Town (Duguma *et al.*, 2022), and 21.2% Waghemira Zone (Debash *et al.*, 2023). This disparity in malaria prevalence rates could be attributed to differences in study design, setting and diagnostics technique. When compared to community-based studies, health facility-based studies may overestimate prevalence. Geographical differences and a high susceptibility to malaria, combined with frequent exposure, may contribute to the variation. The development of population immunity through repeated exposure may result in fewer reported cases (Prusty *et al.*, 2021). The timing of the study, such as during a period of low malaria transmission (from April to May), could explain the lower percentage of reported cases in the current study.

The result of the current study is also lower than the studies in Africa, including Kano State, Nigeria (60.6%) (Dawaki *et al.*, 2016), Ibadan, Nigeria (55.0%) (Awosolu *et al.*, 2021), Mozambique (60.6%) (Earland *et al.*, 2022), Unwanna, Nigeria (54.2%) (Odikamnoro *et al.*, 2018), Malawi (31.1%) (Topazian *et al.*, 2020). This disparity in malaria prevalence rates might be due to national differences in malaria prevalence and burden. Compared to other endemic

countries in Sub-Saharan Africa, Ethiopia has relatively low malaria prevalence. Nigeria, Mozambique, and Malawi have higher rates of malaria cases than Ethiopia (WHO,2021). Differences in lifestyle, socioeconomic status, and housing conditions among communities in different nations may contribute to this variation. Moreover, the diagnostic strategy employed in the current study differed from studies conducted in Kano state, Nigeria, and Malawi. These studies utilized a sensitive molecular technique for malaria detection, capable of identifying asymptomatic infections missed by conventional tests due to low parasite density (Kobayashi *et al.*, 2019).

In the current study, the most common *Plasmodium* species detected was *P. falciparum* (59.0%), followed by *P. vivax* (36.1%). This finding is consistent with previous studies conducted in different parts of Ethiopia, including Chagni (55% *P. falciparum* and 44.3% *P. vivax*) (Belay *et al.*, 2021), Debre Elias district (57.1% *P. falciparum* and 42.9% *P. vivax*), (Abebaw *et al.*, 2022), Maygaba town (63.2% *P. falciparum* and 36.8% *P. vivax*) (Yhdego *et al.*, 2022), Benna Tsemay district (69% *P. falciparum* and 24% *P. vivax*) (Debo and Kassa, 2016), Waghemira Zone (65.0% *P. falciparum* and 31.3% *P. vivax*) (Debash *et al.*, 2023), Kombolcha (60.2% *P. falciparum* and 35.5% *P. vivax*) (Gebretsadik *et al.*, 2018), and Halaba special district (62.3% *P. falciparum* and 38.7% *P. vivax*) (Shamebo and Petros, 2019). This is also consistent with Ethiopia's national *Plasmodium* parasite distribution pattern, where *P. falciparum* and *P. vivax* cause 60% and 40% of the country's malaria cases, respectively (Byrnes *et al.*, 2018). Furthermore, there is a chance of recrudescence because *P. falciparum* is widespread in the lowlands, where the current study area is located (MOH, 2021).

On the other hand, other studies in the country reported a lower prevalence of *P. falciparum* than that of *P. vivax*. A study from the Bahir Dar Zuria district showed that 10.1% *P. vivax* and 3.4% *P. falciparum* (Dejazmach *et al.*, 2021) and also from the East Shewa Zone, the dominant *Plasmodium* species were *P. vivax* 54%, followed by *P. falciparum* 45% (Tadesse *et al.*, 2017). Although it was difficult to explain the above differences, they might be caused by variations in topographic adaptations and intrinsic parasite factors (Alelign *et al.*, 2018).

In the current study, the proportion of malaria varied between symptomatic (30.7%) and asymptomatic (7.3%) participants. This discrepancy could be attributed to the diagnosing techniques used; the current study was done using low-sensitivity techniques (microscopy and RDT). When compared to symptomatic patients, asymptomatic malaria patients have developed partial immunity, which clears the parasite and results in a low parasite density (Doolan *et al.*, 2009). As a result, low-sensitivity techniques like microscopy and RDT may miss detecting asymptomatic malaria (Girma *et al.*, 2019; Kobayashi *et al.*, 2019).

In this study participants with no formal education were nearly three times more likely to be infected with malaria than those with secondary or higher education (AOR: 2.56; 95% CI: 1.10-5.94). This finding is consistent with studies conducted in various parts of Ethiopia (Aschale *et al.*, 2018; Obsie and Gondol, 2021; Adugna *et al.*, 2022) as well as from other African nations (Awosolu *et al.*, 2021; Earland *et al.*, 2022), where it was observed that educational level had a significant association with malaria prevalensce

Malaria is considered as a disease of poverty (Rudasingwa and Cho, 2020). According to the findings of the current study, hparticipants with low monthly income were nearly three times to contract malaria infection than those who have high monthly income (AOR: 2.97; 95% CI: 1.07, 8.25). This could be a result of the poor people's housing conditions, which encourage the proliferation of mosquitoes, limited access to healthcare, and lack of protective measures. Furthermore, this study was conducted in rural areas, which have less easy access to healthcare resources and financial and physical services than urban areas. Additionally, the costs of consultation, transportation, and medications at distant health facilities may be prohibitively expensive for low-income families. As a result, poor-quality housing and a lack of malaria knowledge facilitate disease transmission among low-income households. The prevalence of malaria in Ethiopia is closely linked to the agricultural seasons since agriculture is the primary employment sector for a significant portion of the population. Malaria transmission rates coincide with the planting and harvesting seasons when mosquitoes are more abundant. As a result, individuals infected with malaria may be unable to work in agriculture, leading to economic and nutritional consequences for both individual households and the community at large. Moreover, those with low monthly income face challenges in affording treatment and preventive measures for malaria due to limited financial resources (Alelign and Dejene, 2016).

This socioeconomic factor contributes to the persistently high prevalence of malaria infection among individuals with lower income levels in Ethiopia (Alelign and Dejene, 2016).

The main element of vector control in Ethiopia's National Malaria Prevention and Control Strategies is environmental management (FMOH, 2012). In our study people who live near stagnant water were two times more likely to be exposed to the malaria parasite in the current study than those who did not live near stagnant water (AOR=2.12, 95% CI: 1.14 - 3.99). There were numerous freshwater collections formed during the rainy season around the visited houses, which were ideal for mosquito breeding. A similar finding was reported in a study conducted in different parts of Ethiopia (Fekadu *et al.*, 2018; Obsie and Gondol, 2021; Adugna *et al.*, 2022; Duguma *et al.*, 2022; Tesfaye and Teshome, 2022; Debash *et al.*, 2023).

Long-lasting insecticidal nets (LLINs) are one of the most important vector control measures used in Ethiopia's malaria control efforts. Ethiopia's Federal Ministry of Health (FMOH) recognizes the importance of LLINs in preventing malaria transmission and lowering malaria-related morbidity and mortality rates (FMOH, 2017). According to this study, participants that did not regularly use ITNs had a nearly threefold higher risk of contracting malaria than those who did (AOR: 2.88; 95% CI: 1.13 - 7.32). This finding is supported by similar previous research carried out in different parts of Ethiopia (Aschale *et al.*, 2018; Abebaw *et al.*, 2022; Adugna *et al.*, 2022; Duguma *et al.*, 2022; Tesfaye and Teshome, 2022; Debash *et al.*, 2023). This could be due to a negative attitude toward ITN or uncertainty about using ITN for a variety of reasons, as mentioned by Belay *et al.* (Belay *et al.*, 2021). Furthermore, the use of ITNs may be related to a variety of factors such as education level, malaria knowledge and community engagement, and socioeconomic status of the society. Since ITNs are a successful vector control strategy for preventing the spread of malaria, the chance of getting a mosquito bite may be lowered if they regularly use ITNs. Moreover, individuals without ITNs were 3 times more likely to get malaria compared to those with at least one ITN (AOR: 2.56; 95% CI: 1.14 - 5.75). Lack of ITNs and not using them increases the risk of mosquito bites and malaria transmission. Since ITNs are an effective strategy for preventing the spread of malaria.

As per WHO's recommendation, it is advised to ensure the availability of one ITN for every two individuals (WHO, 2013). The Monitoring and Evaluation Reference Group has also incorporated indicators to track ITN access at the household level, specifically referring to the proportion of households with at least one ITN for every two household members (PMI, 2016). Although the current study area reported the availability of at least one ITN in 79.7% of households, it is important to note that this does not necessarily guarantee the availability of one ITN for every two family members to share. The current study found that only 44.3% of households met this indicator, implying that the current ITN delivery strategies, primarily based on free mass distribution campaigns with operational delivery criteria of one ITN for every two people, may be insufficient to achieve universal coverage of ITNs in malaria-endemic areas of Southern Ethiopia. This suggests a need for a more targeted approach and improved distribution strategies to ensure adequate access to ITNs for every individual in malaria-endemic areas. Achieving universal coverage of ITNs is crucial for effective malaria prevention, reducing mosquito bites, and decreasing malaria transmission.

7. STRENGTH OF THE STUDY

Because this is a community-based cross-sectional study, it was useful to evaluate asymptomatic people who were important carriers of disease in the area and enable them to receive treatment to decrease disease transmission. Furthermore, this study aided in the direct observation of the participants' housing conditions; availability, conditions, and usage of ITNs, as well as the assessment of the presence of stagnant water around the house in the study area.

8. LIMITATION OF THE STUDY

One of the study's limitation was the failure to use more sensitive diagnostic methods such as molecular diagnosis using PCR to further confirm the results obtained through RDT and microscopic examinations.

9. CONCLUSION AND RECOMMENDATIONS

In conclusion, the findings of this study indicate that malaria infection was high in the Loka Abaya district community. *P. falciparum* was found to be the most common *Plasmodium* species in the study area. ITNs were distributed to the households, but none of the houses had been sprayed by the IRS in the three years before the study period. In terms of associated factors, educational status, monthly income, ITN availability and utilization, and the presence of stagnant water around the house were all significantly associated with malaria infection.

Based on the findings, the following recommendations are made.

- The Loka Abaya Woreda Health Office should provide a sufficient number of ITNs to those who do not have them or have an insufficient supply, as well as work to increase ITN utilization in households through community awareness and promotion.
- The Loka Abaya Woreda Health Office should establish programs and strategies to run the IRS service in the district in collaboration with concerned bodies.
- The Loka Abaya Woreda Health Office should implement, strictly follow, and monitor malaria prevention and control measures, such as clearing stagnant water near community residences, in line with national malaria guidelines.
- When people have a fever at home or in their community, community health workers should advise them to seek medical attention as soon as possible. People with and without malaria symptoms should be included in community malaria screenings. This aids in evaluating the effectiveness of control strategies using reliable measures.
- More prevalence research, using highly precise and sensitive molecular techniques, should be conducted during the major malaria transmission season.

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APPENDICES

Appendix-1 Malaria Microscopy

A. Collection of Capillary Blood and Preparation of Thick and Thin Blood Film

Procedure: - Prepare a previously cleaned glass slide and the other materials required for blood collection. Choose the third or fourth finger from the thumb (or, for infants, the big toe). Hold the patient's hand with the palm up and use an alcohol swab or 70% ethanol to clean the chosen finger. To clear the finger's ball of debris and oils and to promote the circulation of blood, use firm strokes. Dry the fingers' alcohol residue.

1. Prick each patient's finger (or big toe) with a new, sterile lancet. Apply gentle pressure to the finger (or toe) to remove the first drop of blood. Wipe the first drop of blood away with dry cotton, making sure that no cotton strands remain on the finger that could stick to the blood.
2. Make both thick and thin blood films (for the same patient) on the frosted side of the same slide.
3. To prepare the thin film, place the edge of a clean “spreader” slide at a 45° angle in front of the blood drop intended for the thin film.
4. Slowly pull the “spreader” back until it touches the drop of blood and it spreads along the edge of the “spreader”.
5. Rapidly push the “spreader” forward (away from the center) in a smooth, continuous motion, until the spreader leaves the bloody part of the slide leaving a “feathery” end for the thin film.
6. With the corner of the same “spreader” used for making the thin film, make the thick film by swirling the 3 drops of blood together forming a circle of about 1.2 cm diameter

B. Staining of Malaria Blood Films

There are three steps to prepare for Giemsa staining of malaria blood films: To begin, adjust the pH of the buffered water to 7.2 for use in preparing the Giemsa stain solution. Second, make the Giemsa stain a working solution for routine staining of malaria blood film. Malaria blood films are then stained with Giemsa.

C. Principle of Giemsa Staining

A freshly prepared working solution of Giemsa, made from well-prepared stock and diluted with water buffered to pH 7.2, is recommended to achieve the optimal staining quality of malaria blood films.

A properly stained blood film is critical for malaria diagnosis, particularly for identifying malaria species. The recommended and most reliable method for staining thick and thin blood films is to use the Giemsa stain. Eosin and methylene blue make Giemsa solution (azure). The parasite nucleus is stained red by the eosin component, while the cytoplasm is stained blue by the methylene component. Methanol is used to fix the thin film. During the process, the thick film is dehemoglobinized and stained at the same time.

A pH of 7.2 is ideal for demonstrating parasite stippling and allowing proper species identification.

D. Examining thick and thin malaria blood films

The thick film lyses and dehemoglobinizes red blood cells (RBCs), while the malaria parasites remain intact and concentrated, allowing for proper detection and identification. When fixed with absolute methanol in the thin film, the RBCs retain their original morphology and, if malaria parasites are present, become visible inside the cells. Malaria diagnosis must be based on well-prepared thick and thin malaria blood films to ensure correct speciation and accurate parasite density estimation.

Detection and identification of the *Plasmodium* species and stages:

1. Place the Giemsa-stained blood film to be examined on the microscope stage
2. Position the thick film in line with the objective lens
3. Switch on the microscope and adjust the light source optimally by looking through the ocular and the ×10 objective (low power)
4. Place a drop of immersion oil on the thick film, and allow it to spread

5. To avoid cross-contamination, ensure that the immersion oil applicator never touches the slide
6. Scan the blood film for parasites and blood elements. Select part of the film that is well stained and has evenly distributed white blood cells
7. Switch to ×100 oil immersion objective over the selected portion of the thick film
8. Raise the mechanical stage until the objective lens gently touches the immersion oil but not the slide
9. Examine the slide systematically. Start at the top left end of the film, begin at the periphery of the field, and then move horizontally to the right, field by field. Alternatively, from the top left end of the film, move vertically downwards to the next adjacent fields. When the other end of the film is reached, move the slide to the right, and then go upwards to the adjacent fields, and so forth

Appendix-2 Principle and Procedure of Rapid Diagnostic Test (RDT) of Malaria

Purpose

Malaria rapid diagnostic tests (RDTs) assist in the diagnosis of malaria by providing evidence of the presence of malaria parasites in human blood. RDTs are an alternative to diagnosis based on clinical grounds or microscopy, particularly where good quality microscopy services cannot be readily provided and also where electric service is not available.

Principle of Malaria RDTs

Variations occur between products, such as targets and formats, though the principles of the tests are similar. Malaria RDTs detect specific antigens (proteins) produced by malaria parasites in the blood of infected individuals. Some RDTs can detect only one species (*P. falciparum or P. vivax*) while others detect multiple species *(P. falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*). Blood for the test is commonly obtained from a finger prick.

RDTs are lateral flow immuno-chromatographic antigen-detection tests, which rely on the capture of dye-labeled antibodies to produce a visible band on a strip of nitro-cellulose, often encased in plastic housing, referred to as cassettes. With malaria RDTs, the dye-labeled antibody first binds to a parasite antigen, and the resultant complex is captured on the strip by a band of bound antibody, forming a visible line (T-test line) in the results window. A control line (C-control line) gives information on the integrity of the antibody-dye conjugate but does not confirm the ability to detect parasite antigens.

Mode of action of common malaria RDT format

1) The first step of the test procedure involves mixing the patient's blood with a lysing agent in a test strip or well. This ruptures the red blood cells, releasing more parasite protein.
2) The dye-labeled antibody, specific for the target antigen, is present on the lower end of the nitrocellulose strip or in a plastic well provided with the strip. The antibody, also specific for the target antigen, is bound to the strip in a thin (test) line, and either antibody specific for the labeled antibody, or antigen, is bound at the control line.

3) Blood and buffer, which have been placed on the strip or in the well, are mixed with labeled antibodies and are drawn up the strip across the lines of bound antibodies.
4) If the antigen is present, some labeled antibody-antigen complex will be trapped and accumulate on the test line. An excess-labeled antibody is trapped and accumulates on the control line. A visible control line indicates that the labeled antibody has traversed the full length of the strip, past the test line, that at least some free antibody remains conjugated to the dye, and that some of the capturing properties of the antibodies remain intact.
5) The intensity of the test band will vary with the amount of antigen present, at least at low parasite densities (antigen concentration), as this will determine the number of dye particles that will accumulate on the line. The control band intensity may decrease at higher parasite densities, as much of the labeled antibody will have been captured by the test band before reaching the control.

Appendix-3 Information Sheet and Consent Form (English version)

Name of the Principal Investigator: Siratu Seyoum Mekonnen

Name of the organization: Hawassa University

Name of the sponsor: Hawassa University, Southern Ethiopia

Information sheet and consent form prepared for respondents selected from three malarious kebeles of Loka Abaya Woreda, Sidama Regional State; Southern Ethiopia.

Title of the study: "Prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda, Sidama Regional State, Southern Ethiopia"

Introduction

Hello, I am_____. I will briefly introduce myself and explain why I am here today. I came to this village to collect research data for Mr. Siratu Seyoum Mekonnen. He is currently a second-degree student in the Master's program in Medical Parasitology at Hawassa University College of Medicine and Health Sciences School of Medical Laboratory Science and is conducting research entitled "Prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda, Sidama Regional State, Southern Ethiopia" for his Master's dissertation. The conduct of the research has been approved by the local authorities and ethically cleared by the Institutional Review Board of Hawassa University. The kebele in which you currently live was randomly selected. Hence, households in this "got" are selected as candidates to participate in the study.

Purpose: The purpose of this research is to assess the "prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda" among the households of three malaria-endemic kebeles. We believe the findings of this study will contribute substantially to improving malaria prevention and control strategies and enhancing the overall reduction of morbidity and mortality related to malaria.

Procedure: To assess the prevalence and associated risk factors of malaria in this village, we invite you to take part in this study. The data collectors will interview and collect blood samples by pricking the finger (heel or big toe for infants) with a sterile disposable lancet. You have full freedom to decide whether to participate or not. If you are willing to participate, you need to understand and sign the consent form. Then, you will be asked to give your response by the data collectors. For this study, one participant is randomly selected from a selected household.

Risk and/or discomfort: By participating in this research, you may feel that it has some discomfort, especially during the blood sample collection procedure, and wastes your time (about 30 minutes). But this may not be too much considering the potential benefits the study contributes to the overall improvement of the health status of the community. There is no physical or psychological risk in participating in this research project.

Benefits: If you participate in this study, you may not get direct benefits, and you will not be given any incentive. However, your participation is likely to help us in assessing the prevalence of malaria and associated factors with infection in Loka Abaya, Sidama, Southern Ethiopia. The research results will give insight to concerned bodies for future planning and intervention of the problems.

Right to refuse or withdraw: You have the full right to refuse to participate in this research (you can choose not to respond to some or all of the questions). If you do not wish to participate, this will not affect the health services you get from any health facilities. You have also the full right to withdraw from this study at any time you wish to, without losing any of your rights as a resident of this site.

Do you have any questions about the research at this stage?

Are you willing to participate in the research? 1) Yes 2) No

Statement of the Consent

The nature of the study entitled ‘Prevalence and associated factors of malaria infection among the community of Loka Abaya district’ and the information described above has been orally explained/read to me in the language I understand well. I believe I can contribute to this study and voluntarily agree to participate.

I _____ hereby give my consent for giving of the requested information and specimen for this study.

Name of participant ---------- Signature/thumbprint----------

Name of the data collector ---------- Signature ----------

Persons to contact: If you have any questions you can contact: Mr. Siratu Seyoum Mekonnen, through the following contact address:-

Tel: 0910883342/0926428886

Email: seyoum8694@gmail.com

Appendix-4 Consent Form (Sidamic version)

Mashalaqete Woraqatanna Sumuu Yaate "forme"

Umi xiinxalaanchi Su'ma: Siratu Seyoum Mekonnen

Universitete Su'ma: Hawaasi Yuniversite

Woxunni kaa'litanno uurinsha su'ma Hawaasi Yuniversite, Wodiidi Itophiya

Mashalaqete woraqati forme qixxaabbinohu Sidaamu Qoqqowi giddo Lokka Abaayyu Woradira ikkanna xiinxallote umi "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada" yitannote.

Eo

Balaxe Keere'ya shiqisheemmo. Su'ma'ya _____ yinanni'e. Techo kawiira dawoommo haja haranchunni egensiiseemmo, kawa dawoommohu, kalaa Siratu Seyoum Mekonnen yinanni manchira yaano Hawaasi Universite rosaanchira xiinxallote hajora ikkitanno mashalaqe (taje) gamba assateeti. Xaa yannara isi Hawaasi Yuniverstera "Medical Parasitolojete" rosi golira layinki (Mastersete) digire rosaanchooti. Xiinxallosi umi "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada" yitannote. Xiinxallosi hajano Hawaasi Universite giddo noo hajo la'annonsa gashshaanonni buuxante fajjantinote (fajjinoonite). Ati heeratto/tta base tini hixunni doorantinotee konni daafira, tenne basera noo mini maate dawaro uyiitara xiinxallote beeqqaano ikkite doorantino.

Mixo/hexxo: Tenne xiinxallote mixo umi "Itophiyuu giddo, Sidaanu Qoqqowinni shekkeerete dhibba gargaranna huna" yaanno. Ninke ammaneemmohu tenne xiinxallo gumulo/gumi/ Itophphiyunni qoleno Sidaanu Qoqqowinni giddonni shekeerete dhibba ajishanna huna lainohunninna hattono rewoo ajishate ledo amadame lowonta kaa'lannotaati.

Horo: Tenne xiinxallora beeqqaancho ikkakkinni rahotenni leeltino horo afira hoogatora/hoogatara dandaato/ta. Ikkollana; kayiini ate beeqqo qoxxeessi'nera batiranni noo sheekeerete dhibba garagarooshshenna qoropho assate lowo geeshsha kaalitanonke. Kuni xiinxallote gumi, Sidaanu Qoqqowi giddo Lokka Abbaayyu woradira dhibbi afammanno deerranna konni dhibbira korkaata ikkannare baala bade afate kaallanno.

Qoleno tenne xiinxallo gumi Konni qarrira taalo dawaronna laooshe aanno.

Misxire (Fojo): Tenne xiinxallonni gamba assineemmo mashalaqqe baala misixiretenni. gamba yitr Hawaasi Universtera maaxante ayeeno iillaranna kisara danadaannokki bayiicho ofoltena xiinxallo loosannohunnina, tajegamba assannohunni gobbaanni dilannanni.

Qarra/injaa hooga: Tenne xiinxallo aana beeqakkinni miteekke mudeekki ha'nanni woyte shiima xisso macciishshantahera dandaanno, qoleno tini xinxallo 30 daqiiqi ale adha daafira tashshi yaa hoogahera dandaanno. Ikkollana kayiinni, tini xiintallo uyiitanno gumi (gumulo) woy uyiitanno horo gobbate deerrinni ikko Sidaamu qoqqowi giddo fayyimmate deerra woyeessa la'inohunni uyiitanno horo ledo heewinsanni woyite hakeeshshano dibatidhinote. Konnirano tenne xiinxallora beeqakkinni mannimakkiranna sayiikoloojekkira qarru diheerannohe.

Giwate qoosso: Tenne xiinxallora beeqqa hoogate wo'ma qoosso noohe (yaano xa'mo gama ikko wo'munni wo'ma qola hoogate qoosso noohe) xiinxallote beeqqa halcho hooguhero, wole umikkira afirato mannimate keeranchimakki aana qarra iilishshahera didandaiitanno. Qoleno tenne xiinxallora beeqqaancho ikkito gedensaanni ayee yannarano fulate dandaatto/tta.

- Kaageeshshi geeshsha nabbbabummorira aana xa'mo nooheni?
- Tenne xiinxallora beeqaancho ikkate umokki fajjatto/fajjatta A. ee B. dee'ni

Sumuu yaa

Tenne xiinxallo umi "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada" yitannota ikkitanna aleenni xawinsi mashalaqqe anera leellanno'e qaalinni afuunni seekine xawinsoonnie.

Tenne xiinxallora umi'ya fajjonni beeqqe kaa'lo asseemmota ammaneemmo. Beeqaanchu su,manna malaate:.....
Taje gamba assaanchu Sumanna malaate:.....

Xaada dandiinanihu: Ayee xa'mo heedhuhero kalaa Siraatu Siyoum Mekonnen, Hawaasi Yuniversite yite xa'ma dandaatto

E-meele: seyoum8694@gmail.com

Bilbilu kiiro: 0910883342/0926428886

Appendix-5 Assent form for mature minors (12-17 years) (English Version)

Study title: "Prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda, Sidama Regional State, Southern Ethiopia"

Name of the Principal Investigator: Siratu Seyoum Mekonnen

Name of the organization: Hawassa University

Name of the sponsor: Hawassa University, Southern Ethiopia

Introduction

Hello, I am_____. I will briefly introduce myself and explain why I am here today. I came to this village to collect research data for Mr. Siratu Seyoum Mekonnen. He is currently a second-degree student in the Master's program in Medical Parasitology at Hawassa University College of Medicine and Health Sciences School of Medical Laboratory Science and is conducting research entitled "Prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda, Sidama Regional State, Southern Ethiopia" for his Masters' dissertation. The conduct of the research has been approved by the local authorities and ethically cleared by the Institutional Review Board of Hawassa University. The kebele in which you currently live was randomly selected. Hence, households in this "got" are selected as candidates to participate in the study.

Purpose: The purpose of this research is to assess the "prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda" among the households of three malaria-endemic kebeles. We believe the findings of this study will contribute substantially to improving malaria prevention and control strategies and enhancing the overall reduction of morbidity and mortality related to malaria.

Procedure: To assess the malaria prevention and control status in this village, we invite you to take part in the research project. The data collectors will interview and collect blood samples by pricking the finger (heel or big toe for infants) with a sterile disposable lancet. You have full freedom to decide whether to participate or not.

If you are willing to participate, you need to understand and sign the consent form. Then, you will be asked to give your response by the data collectors. For this study, one participant is randomly selected from a selected household.

Risk and/or discomfort: By participating in this study, you may feel that it has some discomfort, especially during the blood sample collection procedure, and wastes your time (about 30 minutes). But this may not be too much considering the potential benefits the study contributes to the overall improvement of the health status of the community. There is no physical or psychological risk in participating in this research project.

Benefits: If you participate in this study, you may not get direct benefits, and you will not be given any incentive. However, your participation is likely to help us in assessing the prevalence of malaria and associated factors with infection in Loka Abaya, Sidama, Southern Ethiopia. The research results will give insight to concerned bodies for future planning and intervention of the problems.

Right to refuse or withdraw: You have the full right to refuse to participate in this research (you can choose not to respond to some or all of the questions). If you do not wish to participate, this will not affect the health services you get from any health facilities. You have also the full right to withdraw from this study at any time you wish to, without losing any of your rights as a resident of this site.

Do you have any questions about the research at this stage?

Assent form for children: English version

I have read the information above, or it has been read to me. I have been allowed to ask questions and my questions have been answered to my satisfaction. I voluntarily assent that I will participate in this study and provide my parents or guardians with their consent. I am voluntary to participate in this study and give my blood sample and also, and I have been informed of the right to withdraw from the study at any time.

Are you willing to participate in the study? A) Yes B) No

Statement of the Assent

I _____ hereby give my consent for giving of the requested information and specimen for this study.

Consent form for parents/guardians: English version

I have read the information above, or it has been read to me. I have been allowed to ask questions and my questions have been answered to my satisfaction. I voluntarily consent that my child participates in this study provided; he/she gives assent to collect a blood sample and be a participant in this study and understand that I have the right to withdraw my child from the study at any time.

Participant's code ----------Date----------

Name of parents/guardian's ----------Signature/thumbprint----------

Name of data collector---------- Signature----------Date----------

Appendix-6 Assent form for mature minors (12-17 years) (Sidamic Version)

Umi buuxaanchi Su'ma: Siratu Seyoum Mekonnen

Universitete Su'ma: Hawaasi Yuniversite

Woxunni kaa'litanno uurinsha su'ma Hawaasi Yuniversite, Wodiidi Itophiya

Mashalaqete woraqati forme qixxaabbinohu Sidaamu Qoqqowi giddo Lokka Abaayyu Woradira ikkanna xiinxallote umi "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada" yitannote.

Eo

Balaxe Keere'ya shiqisheemmo. Su'ma'ya _____ yinanni'e. Techo kawiira dawoommo haja haranchunni eqensiiseemmo, kawa dawoommohu, kalaa Siratu Seyoum Mekonnen yinanni manchira yaano Hawaasi Yuniversite rosaanchira xiinxallote hajora ikkitanno mashalaqe (taje) gamba assateeti. Xaa yannara isi Hawaasi Yuniverstera "Medical Parasitolojete" rosi golira layinki (Mastersete) digire rosaanchooti. Xiinxallosi umi "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada" yitannote. Xiinxallosi hajano Hawaasi Universite giddo noo hajo la'annonsa gashshaanonni buuxante fajjantinote (fajjinoonite). Ati heeratto/tta base tini hixunni doorantinotee konni daafira, tenne basera noo mini maate dawaro uyiitara xiinxallote beeqqaano ikkite doorantino.

Mixo/hexxo: Tenne xiinxallote mixo umi "Itophiyuu giddo, Sidaanu Qoqqowinni shekkeerete dhibba gargaranna huna" yaanno. Ninke ammaneemmohu tenne xiinxallo gumulo/gumi/ Itophphiyunni qoleno Sidaanu Qoqqowinni giddonni shekeerete dhibba ajishanna huna lainohunninna hattono rewoo ajishate ledo amadame lowonta kaa'lannotaati.

Horo: Tenne xiinxallora beeqqaancho ikkakkinni rahotenni leeltino horo afira hoogatora/hoogatara dandaato/ta. Ikkollana; kayiini ate beeqqo qoxxeessi'nera batiranni noo sheekeerete dhibba garagarooshshenna qoropho assate lowo geeshsha kaalitanonke. Kuni xiinxallote gumi, Sidaanu Qoqqowi giddo Lokka Abbaayyu woradira dhibbi afammanno deerranna konni dhibbira korkaata ikkannare baala bade afate kaallanno. Qoleno tenne xiinxallo gumi Konni qarrira taalo dawaronna laooshe aanno.

Misxire (Fojo): Tenne xiinxallonni gamba assineemmo mashalaqqe baala misixiretenni. gamba yitr Hawaasi Universtera maaxante ayeeno iillaranna kisara danadaannokki bayiicho ofoltena xiinxallo loosannohunnina, tajegamba assannohunni gobbaanni dilannanni.

Qarra/injaa hooga: Tenne xiinxallote aana beeqakkinni miteekke tashshi yaa hooga'nera dandaanno korkaatuno 30 daqiiqa wo'ma qolatenni sayissinannihuraati. Ikkollana kayiinni, tini xiintallo uyiitanno gumi (gumulo) woy uyiitanno horo gobbate deerrinni ikko Sidaamu qoqqowi giddo fayyimmate deerra woyeessa la'inohunni uyiitanno horo ledo heewinsanni woyite hakeeshshano dibatidhinote. Konnirano tenne xiinxallora beeqakkinni mannimakkiranna sayiikoloojekkira qarru diheerannohe.

Giwate qoosso: Tenne xiinxallora beeqqa hoogate wo'ma qoosso noohe (yaano xa'mo gama ikko wo'munni wo'ma qola hoogate qoosso noohe) xiinxallote beeqqa halcho hooguhero, wole umikkira afirato mannimate keeranchimakki aana qarra iilishshahera didandaiitanno. Qoleno tenne xiinxallora beeqqaancho ikkito gedensaanni ayee yannarano fulate dandaatto/tta.

- Kaageeshshi geeshsha nabbbabummori aana xa'mo nooheni?

I. Qaaqquulle (12-17 diri mereero noore) Sumuu yinota xa'minanni forme

Aleenni noo mashalaqqe seekke nabbabboommo woy seekkine nabbanboonnie. Xa'mono xa'meenna qolloonnie daafo guqqannoeri dinoe. Xiinxallote beeqqate umoya fajoommo daafira Amaya/aniya woymi losirannoehu fajoonsa aa dandaanno. Xinnxallote beeqateno fajjo oommo, angichi'yanino mundee haara dandiinanni qoleno ayi yannara xinxallote gidddonni agure fuleemmotano afoommo.

Tenne xiinxallora beeqqate umikki fajjatto?

A) Ee, umoya fajjoommo B) Dee'ni, umo'ya difajjoommo

Ani _____ kowicho summuu yoommottana namuna'yano (mundee) aate sumuu yoommota egensiiseemmo.

II. Annu/ama woymi lossannohu Sumuu yaanno forme

Aleenni xiinxallote mixo kulammora wo'nallommo, "Bijajote xibbi afamano deerranna xibbaho korkaata ikkanore bada Hawassa Gangaawi Worada, Sidaamu Qoqqowo, Wodiidi Itophiya: Daga meerersitino mitte yanna xiinxallo". Qoleno, xiinxallote gddonni agurre fula dandiinnanitano xawisommo. Anino ayeno fushshe hoola didaandemmo. Konni dafira wo'ma hedo nooe yee hedeemmo. Laboratorete assinanni buuxo lainnohunni aye mashalaqe aate umo'ya fajoommohe. Xiinxallote daafiara coyrana macciishsha dandeemmo afiinni xa'mate kaayyono afirommo. Laboratorete gumano fayyammate ogeeyyera uynannitanna hasirummo yannara xa'ma dandeemmota buuxoommo.

Beeqaanchu koodde----------Barra----------

Amate/annu/lossiranohu su'ma----------Malaate(angichu malaate)---------

Taje gamba assanohu su'ma----------Malaate----------Barra----------

Appendix-7 Structured questionnaire (English version)

Study title: "Prevalence and associated risk factors of malaria among the community of Loka Abaya Woreda, Sidama Regional State, Southern Ethiopia"

Date:_____/_____/2015E.C

Research assistant:_____Sign:_____

Respondent Code:_____/_____

Respondent's kebele:_____ Village_____ Phone number_____

Name of the supervisor _____Sign_____

Instructions: - Please read each question to the respondent clearly and slowly. Then, circle the letter of choice (s) the interviewee selects carefully. For open-ended questions, write the exact answers of the respondent in the spaces provided.

Part one: Socio-demographic characteristics of the study respondent		
No	Questions	Response
1.	How old are you?	_____ (Age in years)?
2.	What is your gender?	A. Male B. Female
3.	What is your educational level?	A. No formal education B. Primary school C. Secondary and preparatory school D. College degree and above
4.	What is your occupation?	A. Farmer B. Merchant C. Student D. Government employee E. NGO employee F. Others (specify) ----------
5.	What is your marital status?	A. Married B. Single C. Widowed D. Divorced

6.	How many people live in your house?	_____persons
7.	What is the estimated monthly income of your family in Ethiopian Birr?	A. <100 B. 101-500 C. 501-1000 D. 1001- 2500

Part two: Clinical data (to be collected by senior healthcare professionals)

Instruction: Please, make a careful assessment and interview to fill in the following information.

1.	Was there a fever within the past 2 days?	A. Yes B. No
2.	Auxiliary temperature at the time of data collection	_____
3.	Loss of energy	A. Yes B. No
4.	Vomiting	A. Yes B. No
5.	Sweating	A. Yes B. No
6.	Headache	A. Yes B. No
7.	Loss of appetite	A. Yes B. No
8.	Chills	A. Yes B. No
9.	Convulsions	A. Yes B. No

Part three: Environmental-related factors

1.	Is there a health facility in this village?	A. Yes B. No
2.	Is there a transportation service from your home to the health facilities?	A. Yes B. No
3.	How long does (minutes) take you on foot to arrive at the health facilities?	_____minutes
4.	Was ITN distributed in this village?	A. Yes B. No
5.	Do you currently have ITN at your home? (If yes, please ask him/her to show the net)	A. Yes B. No
6.	If yes to question number 5, how many bed nets do you have	_____in number

	currently?	
7.	Where did you get the ITN from?	A. Freely from the government B. Purchased C. Got from NGOs D. Others, specify----------

Part four: Information to be filled in by the interviewers

Instruction: Please, maske careful observation and fill in the following information.

A**. ITN availability and usage**

1.	Where was the net found?	A. Hanging lose oversleeping place B. Hanging and folded up and tied C. Not hanging, but not stored D. Stored away unpacked E. Stored away still in the package
2.	What is the reason the net is not hanging for sleeping?	A. Net difficult to hang B. The net is too short C. No space to hang the net D. There is no one to hang the net E. We only hang it at night F. Saving a new net until others are worn G. Other specify_____ H. Don't know
3.	Was there anyone who used a bed net last night?	A. Yes B. No
4.	Who used ITN if Q3 was "yes" the night before? (More than one response is possible)	A. Children <5 year B. Children 5-10 year C. Wife and Husband D. Other adult family member E. Others specify

5.	How frequently do you use ITN?	A. Every night B. Most the nights C. Occasionally D. Only during malaria epidemics E. Only during rainy seasons F. Others, specify----------
6.	What is the condition of the net like?	A. Torn B. Dirty C. Not hanging in the appropriate position D. Others, specify_____
7.	Has this net ever been washed?	A. Yes B. No C. Don't know
8.	If Q4 is yes, how many times has this net been washed in the last six months?	No of times_____
9.	For the last wash, what was used to wash the bed net?	A. Water and bar soap B. Water only
10	Where was the net dried?	A. Outside in the shade B. Outside in the sun C. Inside D. Other (specify)
11	Ask the interviewee if he/she knows how to tack the net.	A. Tack the net properly B. Unable to tack the net properly
B. Respondent's Housing Condition		
1.	What is the type of house?	A. Corrugated roof B. Thatched roof C. Others specify----------
2.	Does the respondent have separate bedrooms?	A. Yes B. No,(if no skip

		Q4)
3.	If yes to question no 2, what is the total number of bedrooms?	---------- number of bedrooms
4.	Does the family have a separate kitchen?	A. Yes B. No
5.	Does your main living room have a window?	A. Yes B. No
6.	Do the windows and doors have screening?	A. Yes B. No
7.	How do you describe the surface of the walls?	A. Very smooth B. Smooth C. Rough D. Very rough with a lot of cracks
8.	Does the house have openings that allow the entry of mosquitoes?	A. Yes B. No
9.	Does the family have a toilet?	A. Yes B. No
10.	Does the family share the house with domestic animals?	A. Yes B. No
11.	Are there potential mosquito breeding sites (stagnant water) around the residence?	A. Yes B. No
12.	Was your house sprayed with IRS in the last 12 months?	A. Yes B. No (skip to question 14)
13.	If yes to question 8, how many months ago was the house sprayed?	_____ months ago
14.	If "no" for question 12, why not spray?	A. ---------- B. ---------- C. ----------
15.	Who did the spray for you?	A. Government

		B. Non-government organizations C. Private organizations D. Other, specify----------
16.	After spraying an insecticide, did you paint the walls of your home?	A. Yes B. No
17.	If you have never allowed insecticide spray to your house before, will you be willing to in the future?	A. Yes B. No C. Not sure

Thank you for participating in this study

End!

Appendix-8 Structured questionnaire (Sidamic version)

Forme 4: Qinaabbino xa'mo yanna

Hajo: "Shekeerete dhibbi afamanno deerra buuxxanna dhiibbaho korkaata ikkannore bada"

Xaphoomu mashalaqqe

Barra: _____/_____/2015

Xinxalote kaa'lancho:_____malaate_____

Dawaraachu kiiro(koodde):_____/_____

Dawaraanchu ollaa: _____

Towataanchu su'ma_____Malaate_____

Hajajo: Eeggotena mitte mittenta xa'mo suutunni dawaroanchoho nabbawisi. Hakiinni, dawaraanchu dorsha qorowoteenn doyisi. Fano xa'mora, dawaraanchuyita halaalaacho dawaro fano darga borreessi

Gafa mite: Dawaraanchu dagoomu, miinjunna mayimmate akata (gara)		
T/k	Xa'muwa	Dawaro
1.	Dirikki me"eho?	_____diro kiiritenni
2.	Koo/Tee	A. Tee B. Koo
3.	Rosikk deerri mageeshshshaati?	A. Rose degennoommo B. Umi-doyichcho gudoommo C. 2^{kki} doyichchonna qixaawoti roso gudoommo D. 3^{kki} deera/dipiloma/digire gudoommo
4.	Loosikki maati?	A. Baatto loosire galoommoho B. Daddalaanchoho C. Rosaanchoho D. Mangistete loseemmo E. Mangistaawe ikkitinokki uurinshshara looseemmo F. Wole, xawisi_____

5.	Adhamekki gari hiittootti?	A. Qeedhichaho/te B. Adhamoommo/ma C. Tidhamoomo/ma D. Gunnitete/shiiroommo
6.	Mine'ne meu manni hee'ranno?	_____manni (kiirotenni)
7.	Aganu eokki birrunni ma geeshsha ikkitanno yite hedatto?	A. <100 B. 101-500 C. 501-1000 D. 1001- 2500

Gafa lame: Shekeerete dhibbi leellishshanno malaata lainohunni

(taje gamba assannohu wonshanno)

Hajajo: Eeggotena worronni mashshaqqe seekkite la'enna xa'mite wonshi

1.	Quwa saino bisu iibbilli noosi?	A. Ee	B. Dino
2.	Wolqa shaqqishshannohe?	A. Ee	B. Dee'ni
3.	Tushshiishshannohe?	A. Ee	B. Dee'ni
4.	Hunkiishshannohe?	A. Ee	B. Dee'ni
5.	Umo damuunsannohe	A. Ee	B. Dee'ni
6.	Itatore/tare giwissannohe	B. Ee	B. Dee'ni
7.	Qiidissanohe	A. Ee	B. Dee'ni
8.	Huxissanohe	A. Ee	B. Dee'ni

Gafa sase: Shekeerete dhibba gargadhate ledo amadantano hajubba

1.	Qarqari'nera fayyimmate owaante uytanno uurrinsha no?	A. Ee B. Dino
2.	Mini'nenni fayyimmate uurrinsha geeshisha hodhishshu kaa'lo no?	A. Ee B. Dino
3.	Fayyimmate uurrinsha iillate lekkatenni me''e daqiiqa	_____daqiiqa

	fajjanno'ne?	
4.	Ollii'nera daallasu agobere beenkoonn? *Dawarro "ee "yitannota ikkituro leellishshannohe gede xa'mi*	A. Ee B. Dino
5.	Xaa yannara minekki dallasu agobere noohe?	A. Ee B. Dino
6.	Xa'mo shoolete dawaro "ee" ikkituro, xaa yannara me''e daallasu agobere noohe?	_____ kiirotenni
7.	Daallasu agobere mamiinni afirootto?	A. Mangistetewini B. Hidhoommo C. Mangistaawe ikkitinokki uurinshshawin D. Wole, xawisi_____

Gafa shoole: Xa'maanchunni wo'mitanno mashalaqqe

Hajajo: Eegotena seekkite buuxo assite aante noo mashalaqqe wonshi

A**. Agobere afiranna horonsira la'nohunni**		
1.	Daallasu agobere gonxanniwa sutantino?	A. Ee B. Disutantino
2.	Agobere gonxannikiwa sutama hooguro, suntannikki gede assino korkaati maati?	A. Agobere sutate qarrissanno B. Agobere lowo geeshsha haranchote C. Agobere suntanni baychi dino D. Agobere sutannoehu dino E. Hashsha calla suxxineemmo
3.	Sai hashsha woy ankarro dallasu agobere giddo goxino manni no?	A. Ee B. Dino

4.	Xa'mo saykite dawaro "Ee" yitanota ikkituro, sai hashsha daallasu agobere ayi horonsirino woy agoberete giddo ayi goxino?	A. 5 diri woro qaaqqulli B. 5-10 diri giddo noo qaaqqulli C. Amanna annu D. Wolu maatete mili wedellichi E. Wole, xawisi----------
5.	Daallasu agobere akati maa lawanno (dawaro doyisi)	A. Dadhantino B. Xurtino C. Dargase disutantino D. Wole, xawisi_____
6.	Daalasu agobere hiitto wote horonsiratto?	A. Hashsha baala B. Haammata hashsha C. Sae sae D. Shekeerete dhibbi batiranno woggara calla E. Xeenu woggara calla F. Wole, xawisi
7.	Tenne agobere hayshshitine egentinoonni?	A. Ee B. Diegeninoonni
8.	4kki xa'mora dawaro "ee" ikkitturo, sai 6 agani giddo me"e hinge hayshshinoonni?	_____kiirotenni xawisi
9.	Maa horonsidhine hashshitinni?	A. Saammuna waa B. Waa calla
10.	Mama hagine mooshshitinni?	A. Gobba Caaleho B. Gobba arrishshote C. Mine D. Wole, xawisi?
11.	Dawaro qolanno manchi dallasu agobere sutanno gede	A. Ragunni sutino

	assi?	B. Ragunni suta didandiino
B. Dawaro qolanno manchi mini gara		
1.	Minu ma daniho?	A. Qorqorrote mineeti B. Buuyyote mineeti C. Wole xawisi_____
2.	Gonxanni dargi baxxinohu noo?	A. Ee B. B. Dino(4^{kki} xa'mo kubbi)
3.	Xa'mo layinkite dawaro "ee" yittanotta ikkituro gonxann dargi me"eho?	_____ kiiotenni
4.	Sagale qishi'nannihu baxxino mini no?	A. Ee B. Dino
5.	Hee'nanni minira maasikoote no?	A. Ee B. Dino
6.	Waalchohonna masikootete maggaaraju no?	A. Ee B. Dino
7.	Minu gidigida ma garinni la'atto?	A. Low geeshsha taalinoho B. Taalinoho C. Ditaalino D. Hiinxa noosi
8.	Mineho biinne eessitano xulluwa no?	A. Ee B. Dino
9.	Maatete shumate mini noonsa?	A. Ee B. Dino
10.	Mannunna saada mitteenni galtanno?	A. Ee B. Dee'ni
11.	Biinne qalama daudiitanno dorgi (garino wayi) minu qarqarira no?	A. Ee B. Dino
12.	Mini'nera biinne shaanno xaggicho yanna yannatenni kiinfanni?	A. Ee B. Dee'ni (xa'mo 14 kubbi) C. Diafoommo
13.	Xa'mo 12 te dawaro "ee" yitanotta ikkituro meu agani albaanni kiinfoonni?	_____agani albaanni
14.	Xa'mo 12 te dawaro "dee'ni" yitanota ikkituro, mayra dikiinfonni?	A. ---------- B. ---------- C. ----------

15.	Ayi kiifi'no'ne?	A. Mangiste B. Mangitawe ikkitinokki uurinsha C. Mittu manchi uurinsha D. Wole, xawisi----------
16.	Biinne shaanno xagicho ganittohu gedeensanni, minikki girgidira qalame ganootto?	A. Ee B. Dee'ni
17.	Konni albaanni minikira biinne shaanno xagicho kiinfannihera fajjoottokki ikkiro, konni albilitte fajjatto?	A. Ee B. Dee'ni C. Mure diafeemmo

Xinxallote beeqqakkira lowo geeshsha galaxxeemmohe

Goofimaarchoho!