HAWASSA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF MEDICAL LABORATORY SCIENCES

MAGNITUDE OF URBAN MALARIA AND ITS ASSOCIATED RISK FACTORS IN DAMBOYA TOWN, KEMBATA ZONE, CENTRAL ETHIOPIA

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NOVEMBER:-2023

HAWASSA, ETHIOPIA

MAGNITUDE OF URBAN MALARIA AND ITS ASSOCIATED RISK FACTORS IN DAMBOYA TOWN, KEMBATA ZONE, CENTRAL ETHIOPIA REGION

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

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HAWASSA, ETHIOPIA

DECLARATION

I Biruk Mulachew do hereby declare that this thesis entitled “magnitude of urban malaria and its associated risk factors in Damboya town, Kambata Zone, Central Ethiopia Region”. A community based cross sectional study is my original work that all source of materials used for this thesis has been duly acknowledged. This work has not been submitted partially, or in full, by any other person for an award of a degree in any other university and l carried out the study under the guidance and supervision of Dr. Solomon Asnake (Ph.D., associate professor) and Mr. Temesgen Bizuayehu (MSc), the assistance and help received during this investigation have been duly acknowledged. .

Name of candidate: _____Signature Date_____

This MSc in Medical Parasitology thesis has been submitted for examination with my approval as thesis advisor.

Major advisor:-_____Signature:-_____ Date_____

Co-advisor:-_____Signature:-_____ Date_____

ADVISOR'S APPROVAL SHEET

This is to certify that a thesis entitled "Magnitude and associated risk factors of urban malaria in Damboya town, Kambata Zone, Central Ethiopia, 2023: submitted in partial fulfillment of the requirement for the degree of master in Medical parasitology, the graduate program of the School of Medical Laboratory Sciences, and has been carried out by Biruk Mulachew ID No GPMePaR/0009/14 under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the school.

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Co-advisor_____Signature _____Date_____

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We, the undersigned,members of the Board of Examiners of the final open defense by Biruk Mulachew have read and evaluated his thesis entitled entitled "Magnitude and associated risk factors of urban malaria in Damboya town, Kambata Zone, Central Ethiopia, 2023, and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree.

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Co-advisor_____Signature _____Date_____

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Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the school of graduate studies (SGS) through the department/school graduate committee (DGC/SGC) of the candidate's department.

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LISTS OF ACRONYMS AND ABBREVIATIONS

AOR	Adjusted odd ratio
BF	Blood film
COR	Crude odd ratio
CSA	Central statistical agency
FMOH	Federal Ministry of Health
IRS	Indoor residual spraying
ITN	Insecticide-treated nets
LLIN	Long-lasting insecticide net
MIS	Malaria indicator survey
MOH	Ministry of Health
NHS	National Health service
P.f	*Plasmodium falciparum*
P.v	*Plasmodium vivax*
PHC	Primary Health Care
RBC	Red blood cells
RDT	Rapid Diagnostic Tests
SSA	Sub- Saharan Africa
SPSS	Statistical package for social science
SOP	Standard operating procedure
WHO	World health organization

ABSTRACT

Background: In Africa, urban malaria is emerging as a potential Health problem. Because of the rapidly growing number of towns in Ethiopia, there is a persistent need to improve the understanding of the epidemiology of urban malaria.

Objective: This study aimed to determine the prevalence of urban malaria and its associated risk factors in Damboya town Kambata Zone, Central Ethiopia region.

Methods: A Community-based cross-sectional study was carried out in Damboya town from March 7 to May 29, 2023. A total of 422 individuals were randomly selected and a structured questionnaire was employed to collect socio-demographic data and malaria-associated risk factors. Finger/ heel prick blood was used to detect malaria parasites by light microscopy and malaria rapid diagnostic test. Data were entered in Epi data 3.1 and analyzed in SPSS version 25 software. The association between dependent and independent variables was explored by using binary logistic regression analyses. An adjusted odds ratio with a 95% confidence interval was calculated and the association was declared at a P-value of <0.05.

Result: The overall prevalence of malaria was 5% (95%CI:3.1-7.5) with the predominant *P. vivax* infections accounting for 61.9%. The presence of stagnant water (AOR=3.88, 95% CI: 1.14-13.22, P=0.030), unavailability of insecticide-treated bed net (AOR=3.24, 95% CI: 1.01-10.41, P=0.048), living in a house with eaves (AOR=4.22, 95%CI: 1.17-15.00, p=0.027), were more significantly associated with malaria prevalence.

Conclusion: Malaria is still a public health problem in Damboya town. Thus, improved access to all malaria interventions is needed to interrupt the transmission in the community of this town.

Keywords: Prevalence, urban malaria, risk factors, Damboya town, Ethiopia

1. INTRODUCTION

1.1. Background

Malaria is an acute febrile illness caused by *Plasmodium* parasites, which are spread to people through the bites of infected female Anopheles mosquitoes (WHO, 2022). Five species of *Plasmodium* can infect humans and cause illness: *P. falciparum, P. malariae, P. vivax, P. ovale and P. knowlesi.* The most deadly form of malaria is *P. falciparum*, which is commonly found in Africa, especially across much of Sub-Saharan Africa. Most nations outside of sub-Saharan Africa are dominated by the malaria parasite *P. vivax* (Kiran *et al.*, 2020). Anopheles gambiae, the major malaria vector in several African countries, is the most well studied mosquito (Mathanga *et al.*, 2016).

Clinical presentations are fevere, severe anemia, thrombocytopenia, chills, headache, myalgia, malaise, vomiting, muscle aches, and anorexia. The initial symptoms could be varied and cannot be distinguished from those of other febrile illnesses. Diagnosis of malaria depends on the demonstration of parasites in the blood usually by microscope. Additional laboratory findings may include mild anemia, mild decrease in blood platelets, elevation of bilirubin and elevation of aminotransferase (Siahaan, 2018). Most common intervention is vector control and case management. The common antimalarial medications for *P. falciparum* and *P. vivax* infections, respectively, are artemether-lumefantrine (AL) and chloroquine (CQ)(Gebreyohannes *et al.*, 2017)

Climatic conditions (such as priciptation, temperature and humidity), staginant water, unavailability of ITN, and inadaquete Heath sevice are the main risk factors influencing malaria (Haileselassie, *et al.*, 2022). Malaria is transimmited to human by the bite of an infected female Anopheles mosquito. It may also be spread by transfusion of blood from infected people or by the use of contaminated needle and from mother to child through placenta. Pregnant women, children under five and people living with HIV/AIDS are highly vulnerable groups.

In Ethiopia ,*P. falciparum* and *P. vivax* are the most common malaria parasites in the nation, while *P. malaria* and *P. ovale* are uncommon and only account for less than 1% of all malaria

cases that have been diagnosed (Merrick, 2017). *An. arabiensis* is the primary mosquito vector that primarily spreads the parasites, with *An. pharoensis*, *An. funestus*, and *An. nili* serving as secondary vectors (Daygena, Massebo and Lindtjørn, 2017). *An.stephensi*, a novel malaria vector, was recently found. Seasonal malaria transmission occurs in Ethiopia's midlands between 1,000 and 2,200 meters above sea level (Bugssa and Tedla, 2020). The main transmission occurs between September and December main rainy season, while minor transmission occurs from April to June following a brief rainy season (Nabatanzi *et al.*, 2022).

Malaria is typically associated with rural settings, although it can also thrive in urban areas where suitable larval sites are created (Vanhuysse *et al.*, 2023). Today, evidence suggests that economic development and various environmental changes during the twentieth century have reduced malaria incidence in urban contexts (André *et al.*,2019). However, unplanned development of some African towns and global warming is resulting in several breeding grounds for the mosquitoes that carry the malaria parasite and we are seeing the emergence of urban malaria, which could develop into an epidemic at any time (Teka *et al.*,2023)Irrigation systems invariably indicate considerable changes in the environment, thus establishing rural regions in urban centers (Vanhuysse *et al.*, 2023). Additionally, a decrease in health services and a rise in drug resistance are contributing to the spread of urban malaria (Boyce *et al.*, 2019). Furthermore, leaving domestic containers to collect rainwater for a long time transforms them into ideal mosquito breeding sites (Mathanga *et al.*, 2016). Unprotected domestic wastewater disposal around homes without individual sanitation systems also creates standing water that facilitates mosquito breeding (Dlamini *et al.*, 2017).

Ethiopian towns are defined by inadequate housing, inadequate sanitation, poor surface water drainage, inadequate Health services, and widespread economic disparities like most developing country towns in Africa (Adugna, 2023). All of which, individually or collectively, facilitate the transmission of urban malaria (Delil *et al.*,2016). Determining the appropriate malaria intervention approaches in urban areas where malaria is spreading requires an understanding of the determinant variables and scale of the disease. Thus, the purpose of this study was to ascertain the prevalence of urban malaria and the risk factors linked to it in Damboya town, Kambata Zone Central Ethiopia Region.

1.2. Statement of the problem

Despite effective control and elimination strategies, malaria remains a major public health concern. (Boyce *et al.,* 2019). It is mainly found in rural areas, where the vector finds a conducive environment for breeding (Wilson *et al.,* 2015). The number of malaria cases increased from 245 million in 2020 to 247 million in 2021, according to the most recent World Malaria Report (WHO, 2022b). In 2021, 619,000 malaria-related fatalities were anticipated, declining from 625,000 in 2020 (Pahari and Debnath, 2023). Over the two peak years of the pandemic (2020–2021), COVID-related setbacks increased malaria cases by around 13 million and fatalities by 63,000 (WHO, 2022).

The malaria load continues to fall disproportionately heavily on the African Region (Leal Filho, WalterMay, JuliaMay, MartaNagy, 2023). In 2021, about 95% of all malaria cases and 96% of all malaria deaths occurred in this region (WHO, 2021). Sub-Saharan Africa accounted for 60% of global cases and 90% of global fatalities (WHO, 2018).

Ethiopia is also among nations in Africa with the highest rates of susceptibility to malaria epidemics, with morbidity and mortality rates rising significantly during pandemics. According to the Ethiopian FMOH, 68% of the population lives in areas where malaria is a problem, and the country is home to 75% of cases of the disease (Girum, Shumbej, and Shewangizaw, 2019)

Malaria remains a serious threat to human life and the affects economies of the nations, as it is a leading source of illness and mortality in the country (Haileselassie *et al.*, 2022). Due to its effects on fertility, population growth, saving, investing, and declining productivity, malaria obstructs progress (Oluwatayo, 2014). Premature death, low school attendance, and income loss were all associated with the condition. Furthermore, because the expense of treating, diagnosing, preventing, and caring for the disease raises the medical budget, malaria has a major negative economic impact (Alonso *et al.*, 2019).

Ethiopia's efforts to prevent and control malaria mostly focus on rural areas, according to the National Strategic Plan (2006-2010) (Angel *et al.*, 2016). The long-held idea that urbanization reduces the possibility of vector breeding and, as a result, malaria transmission, is the cause of this. Urban microhabitats, however, promote the quantity of Anopheles vectors and have an impact on how likely they are to bite humans (Pindolia *et al.,* 2013). Due to rising construction-related global

warming and development activity, malaria poses a problem in urban areas (Anwar *et al.*, 2022). Ethiopia is still among the countries known for having a very high malaria burden, which is affecting the health of the people living in that area as evidenced by the deaths of people in this area including children and pregnant women which consequently results in reduced working capacity and other day-to-day activities of the community as general (Legesse, Haji and Abreha, 2015). A recent study revealed that urban malaria cases were reported from Debra Elias and Batu town. The prevalence of urban malaria in Ethiopia ranges from 0.9% to 6.1% (Tilaye, Tesfaye, Deressa, 2007; Abeba Alemu, 2011; Woyessa *et al.*, 2012; Debo and Kassa, 2016; File, Temesgen Dinka, 2020; Abebaw *et al.,* 2022; Hassen and Dinka, 2022).

Smaller urban and partially rural settings contain elements that are typical of very big metropolitan contexts (e.g., improved housing, accessible and available health care, greater population density, as well as access to transportation and markets). On the other hand, certain urban areas may also exhibit features associated with rural environments. In Damboya town there are road construction area, irrigation sites those might give mosquetoes breed grounds (Larson *et al.,* 2021). The effectiveness and efficiency of targeted treatments should be enhanced by a deeper comprehension of how various aspects of urbanization may affect *Plasmodium* transmission over the urban-to-rural landscape gradient (Larson *et al.,* 2021).

Testing for malaria may be delayed or unavailable if it has been assumed that malaria is rare or nonexistent in urban areas (Bousema *et al.,* 2012). The preceding malaria research in Ethiopia essentially focused on rural areas and as a result, a few researchers have been addressing urban malaria. Although a few studies were done regarding urban malaria most studies were conducted in health facilities. There is a research deficiency in active case detection of urban malaria in the public community particularly in the study area. To scale up intervention initiatives, it is important to have information regarding the prevalence of urban malaria and its related risk factors in the community. Therefore, this study was initiated to assess the prevalence of malaria and its predisposing factors in Damboya town, Kambata Zone, Central Ethiopia Region.

1.3. Significance of the study

This study was conducted in Damboya town Kambata zone, central Ethiopia to determine the magnitude of urban malaria and associated risk factors. The results of the study may also help the local health centers and concerned health offices to know the burden of malaria and prevalent species in the study area and to plan well-organized malaria prevention and control programs and/or scale up the existing prevention and control mechanisms of malaria. Indicating which type of *Plasmodium* species are the most prevalent in the study area is essential for devising management strategies. In addition, it will help to evaluate the effectiveness of malaria interventions being implemented in the study area. Furthermore, the study will be used as recent information for those who need to conduct further investigation in the area.

2. LITERATURE REVIEWS

2.1. Prevalence of malaria

Malaria is a serious public health issue that continues to cause illness and death throughout the world. The number of malaria cases increased from 245 million in 2020 to 247 million in 2021, according to the most recent World Malaria Report (WHO, 2022b). In 2021, 619,000 malaria-related fatalities were anticipated, down from 625,000 in 2020 (Pahari and Debnath, 2023). The majority of malaria cases in South America occur in the Amazon region(Johansen IC, Rodrigues, and Ferreira, 2020). In Latin American tropical and sub-tropical areas there are still several malaria-endemic regions that impose a considerable burden on local populations. The threat of malaria is highest in sub-Saharan Africa, and 6 countries in that region accounted for more than half of all malaria deaths worldwide in 2020: Nigeria (26.8%), the Democratic Republic of the Congo (12%), Uganda (5.4%), Mozambique (4.2%), Angola (3.4%) and Burkina Faso (3.4%). More than 50 million people in Ethiopia are in danger from malaria, which is thought to cause 4-5 million cases and 70,000 fatalities each year (Monroe *et al.*,2022). The southern nation's nationalities and people's regions have one of the highest malaria burdens in the country, accounting for 18% of total malaria cases reported nationally in 2020 (Deribew *et al.*, 2017).

2.2. Prevalence of urban malaria

Malaria is not only limited in Africa's rural areas. But, also spreading to urban areas due to an increase in population density and environmental change (Teka *et al.*,2023). The United Nations Environment Programme predicts that 800 million people will live in urban areas on the continent by 2025, with 40 cities in Africa already having populations of one million or more. Urban malaria prevalence rates are highly variable, even within a single city or town (Doumbe *et al.*, 2021). The global prevalence of urban malaria cases where shown to account for 6% to 28% of the estimated global malaria incidence (Wilson *et al.*, 2015). In Ethiopia, malaria transmission is unstable, and heterogeneous in space and time. In the 2015, Malaria Indicator Survey (MIS) malaria infection prevalence was 0.6% among the urban residents areas.

A study from Batu town found that 17.13% of the 356 people who were tested for malaria parasites were positive. The largest infection rate was recorded by the *P. vivax* species (50.8%), followed by

P. falciparum (45.9%), and 3.3% of patients had mixed infections, according to the study's examination of infection rates by *Plasmodium* species (Hassen and Dinka, 2022) A study conducted in Butagira area revealed 0.9% prevalence rate of malaria of which 86.5% were positive for *P. vivax* and 12.4% for *P. falciparum*; the remaining two (1.1%) showed mixed infections of *P. falciparum* and *P. vivax* (Woyessa *et al.*, 2012).

The prevalence of malaria among 461 examined study participants was 6.1 % in the Benna Tsemay district of northern Ethiopia. The infection rate with *P. falciparum* and *P. vivax* was 64.3 % and 21.4 % respectively, while the mixed infection was 14.3 % (Debo and Kassa, 2016). According to a study done at the Chichu and Wonago Health Center, 28.1% of the 324 participants had malaria cases. According to the study, *P. vivax* was the most common *Plasmodium* species found at 52.75% followed by *P. falciparum* at 35.16%, and mixed malaria infections caused by both species at 12.09% (Molla *et al.*, 2016). Another study conducted in Quibdo town showed that 72% of cases were due to *P. falciparum* alone, 24% to *P. vivax* alone, and 4% to mixed (*P. falciparum plus P. vivax*) infections (Osorio 2004).

From a total of 804 research participants, only 42 (5.2%) tested positive for malaria parasites in a study done in Jimma town. *P. vivax, P. falciparum*, and mixed infection, respectively, accounted for 71.4%, 26.2%, and 2.4% of cases, according to the study (Abeba Alemu, 2011). 439 patients in total took part in the study at Mizan Tepi University, and 20.7% of them (91) tested positive for malaria parasites (Duguma *et al.*, 2022). Research in Olanchity town involved 306 respondents, giving it a response rate of 100%. When febrile patients visited public health, 27.8% tested positive for malaria, with *P. vivax* being the dominating species with 14.1% of cases, followed by mixed cases with 8.5% (Monroe *et al.*, 2022)

A cross-sectional study centered on the community was carried out in a few chosen kebeles in the Debre Elias district, Amhara region, northwestern Ethiopia. In all, 440 people (333 asymptomatic and 107 symptomatic) were enrolled in the study. The total frequency of malaria was 5%, with *P. falciparum* infections accounting for 59.1% of all infections (Abebaw *et al.*, 2022).

According to a study done in the Hadiya zone, 106 (25.7%) of feverish patients who attended sampling medical institutions tested positive for malaria by microscopy. *P. vivax, P. falciparum*,

and mixed infection together made for 71.7%, 25.5%, and 2.8% of those cases, respectively (Tarekegn *et al.*, 2021).

According to an institution-based cross-sectional study that was carried out among 317 feverish adult patients at Siraro district Health facilities in Oromia Regional State 41.0% malaria prevalence (Yohanes *et al.*, 2022). The cumulative rate of malaria positivity recorded in the Oromia Special zone, Amhara Regional State, North-East Ethiopia, was 12.5%, according to the shifting malaria pattern and control activities carried out in the area. The most common cause of malaria, accounting for 78.9% of cases, was infection with *P. falciparum*. The age group with the highest burden of malaria was discovered to be those over 15 years 54.14% (File and Chala, 2021).

2.3. Associated risk factors of malaria

Understanding the factors that contribute to the reported malaria cases from urban areas is very important for planning and implementing appropriate malaria interventions (Teka *et al.*,2023). According to studies, the risk of contracting malaria was dramatically increased by housing buildings and not utilizing insecticide-treated bed nets for the previous six months. Malaria was more prevalent among people whose homes contained stagnant water than those without it (Molla *et al.*, 2016). A case-control study According to a study conducted among Quibdo town residents, visiting a region where malaria is endemic increases the risk of contracting the disease. The highest risk factor for *P. falciparum* was found to be avoiding Quibdo town in a malaria-endemic area during the 8–14 days before disease onset. Males between the ages of 5 and 14 who have a history of having malaria at home within the previous month are also included (Haileselassie *et al.*,2022).

According to a study done in the area of Jimma town, children under the age of five had a higher prevalence of malaria (11%). In comparison to individuals who use ITN, those who do not use ITN are more likely to contract malaria. In comparison to people who live farther away from stagnant water at a distance greater than 1 km, those who lived in locations where stagnant water existed and was located less than 1 km from their homes were more likely to contract the malaria parasite (Abeba Alemu, 2011). Malaria infections were reported in 20.5% of cases when insecticide-treated bed nets (ITN) were not available to the public in 23.9% of cases and 5.5% of cases among people aged 25 to 34. Patients who lived near stagnant water were more likely to contract the malaria

parasite than those who did not, and people who lived in homes that had not been treated with pesticides were more vulnerable to contracting the disease (Duguma *et al.*, 2022).

In univariate studies a higher level of education was found to be negatively linked with malaria disease in Blantyre, Malawi; these correlations held in both urban and peri-urban areas. Only people who lived in urban areas showed a high association between clinical malaria and travel in the month before testing. In multivariate studies, recent travel and a greater level of education were all linked to a lower risk of malaria (Mathanga *et al.*, 2016).

A study carried out in the Hadiya region found that history of travel to malaria-endemic regions, failure to use bed nets, inadequate malaria preventive and control practices, and the estimated distance of stagnant water from the dwelling were all substantially correlated determinants of malaria positivity (Delil *et al.*, 2016). Substantial correlation between malaria infection and the use of insecticide-treated nets (ITN), availability of ITN, eaves-covered homes, previous history of malaria infection, and family history of malaria infection (Abebaw, *et al*, 2022).

According to a study conducted in two areas in the Dembiya district males are more likely than females to contract malaria, and people who engage in frequent outdoor exercise are more prone to the disease than people who engage in little or no outdoor activity(Tarekegn *et al.*, 2021). A geographical cluster of malaria incidence revealed that case HHs were considerably more likely to have domestic and/or per-domestic animals than control HHs when they were closer to a water drain (less than 200 meters), larger than 5 individuals, lacking potable water, and having domestic animals (Paula *et al.*,2019).

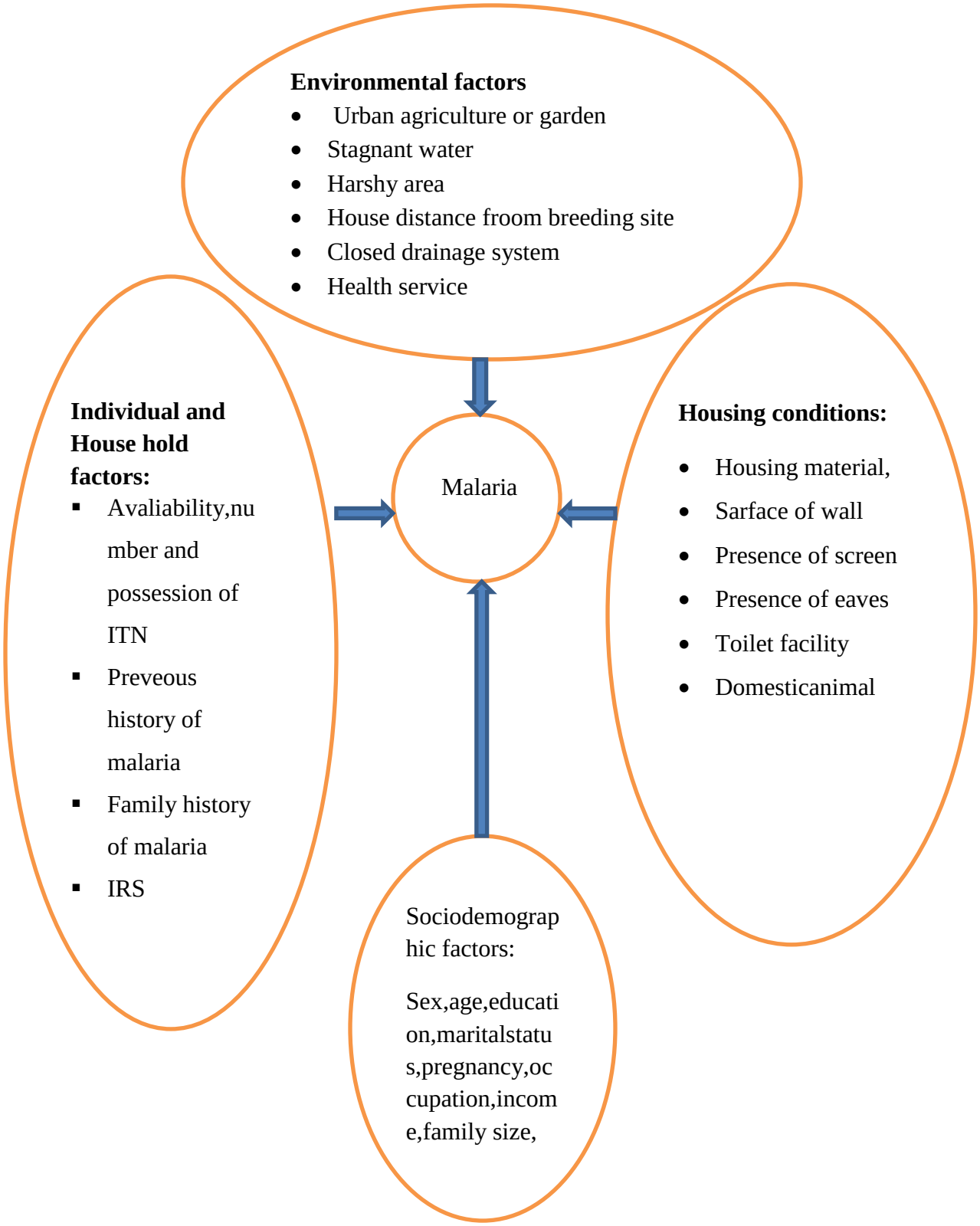


Figure 1 Conceptual framework to determine the prevalence and associated risk factors of urban malaria in Damboya town, Kambata Zone, Central Ethiopia region March 7 to May 29, 2023

3. OBJECTIVES

3.1. General objective

The general objective of this study was to determine the prevalence and associated risk factors of urban malaria in Damboya town, Kambata Zone, Central Ethiopia, March 7 to May 29, 2023

3.2. Specific objectives

- ✓ To determine the prevalence of urban malaria in Damboya town, Kambata Zone, Central Ethiopia region, March 7 to May 29, 2023
- ✓ To identify risk factors associated with urban malaria in Damboya town, Kambata Zone, Central Ethiopia region, March 7 to May 29, 2023

4. METHODS AND MATERIALS

4.1.Study area

This study was conducted in Damboya town. Damboya is the administrative capital of the Damboya Woreda district of the Kambata zone. The town has three Kebeles, namely Damboya 01, Damboya 02 and Geyota Garba. It is one of the most densely populated areas in the central Ethiopia region. The total population of the town was 21, 920 (10,741 male and 11,179 female) (CSA,2020). It is located about 266.1 km away from Addis Ababa to the south and 12 km south of Durame town, the capital of the Kambata zone. The geographical coordinates are 6°23’30” N latitude and 36° 7’23” E longitude. The town is bordered on the south by Kedida Gamela, on the west by Angacha, on the north by Hadya zone, and on the east by the Bilate River which separates it from the Alaba zone. In the town, there are three health posts, one health Centre, and four private medium clinics. The town is found at an average altitude of about 1,898.76 m above sea level. It lies in the climatic zone locally known as “Woyna Daga” (1,500-2,400 m above sea level) which is considered ideal for agriculture as well as human settlement. The town is generally characterized by a warm climate with a mean annual maximum temperature of 27.5°C and a mean annual minimum temperature of 12.6°C. The annual rainfall ranges from 1001-1400 mm. The maximum precipitation occurs during the three months from June through August, with minimum rainfall occurring in December and January.

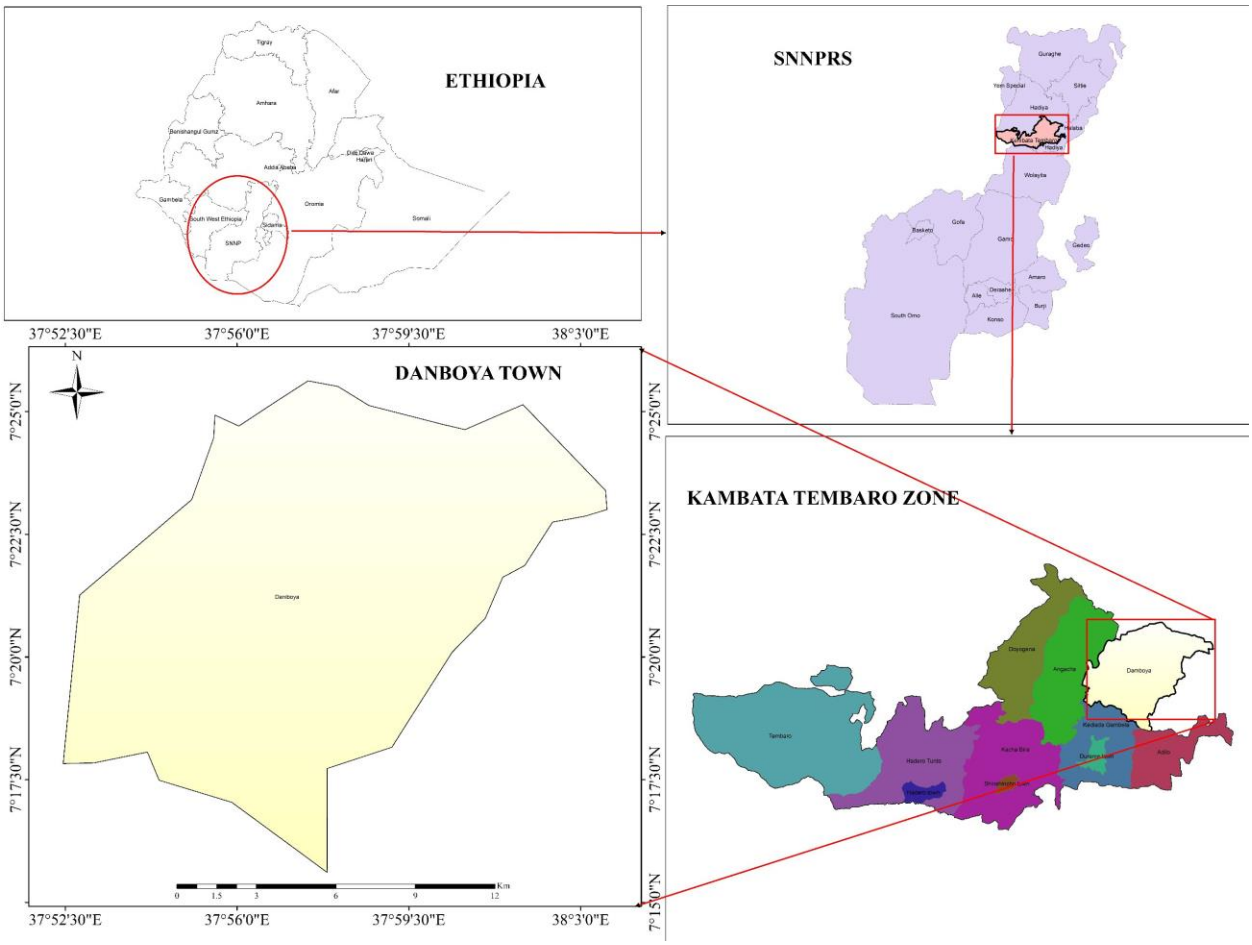


Figure 2 Map of the study area to determine the prevalence of urban malaria in Damboya town, Kambata Zone, Central Ethiopia region, March 7 to May 29, 2023

4.2. Study design and period

A community-based cross-sectional study was conducted in Damboya town, Kambata Zone, Central Ethiopia region, from March 7 to May 29, 2023,

4.3. Study populations

4.3.1. Source population

All households of Damboya town during the study period were our source population

4.3.2. Study population

All members of randomly selected households of Damboya town during the study period were our study population.

4.3.3. Study unit

A randomly selected individual from selected households of Damboya Town during the study period was our study unit.

4.4. Eligibility criteria

4.4.1. Inclusion Criteria

All individuals with and without signs and symptoms of malaria and available during the study period and agreed to participate in the study were included.

4.4.2. Exclusion Criteria

Any one who came to those households during the study period and any individuals who were not willing to participate in the study were excluded from the study. Individuals who were on antimalarial drug treatment within the last four weeks were excluded (Abeba Alemu, 2011). Those who were seriously ill and unable to provide blood samples and Socio-demographic data were excluded.

4.5. Sample size calculations

The sample size for the study was estimated using a single population proportion formula n=$(z - \alpha/2)^2 \frac{p(1-p)}{d^2}$ Where; n= sample size, an expected prevalence (p) of 50%, Z = confidence level at 95% (1.96), α =level of significance (5%) and d= margion of error (5%),

n=$(1.96)^2 * 0.5(1 - 0.5)/0.05^2 = 384$

By adding a 10 % non-response rate, the final sample size was 422.

4.6. Sampling techniques

A systematic random sampling technique was employed to obtain the estimated households and simple random sampling techniques to obtain study units. The study was conducted in the community of Damboya town. The town has three kebeles, namely, Damboya 01, Damboya 02, and Geyota Garba. The size of the households in Damboya 01,02, and Geyota garba kebeles was 1,561, 1,512, and 1,306 respectively. The Sample size was proportionally allocated to each kebeles based on demographic registration of household size. Accordingly, 150 households were selected from Damboya 01 kebele, 146 households were selected from Damboya 02 kebele, and 126 households were selected from Geyota garba kebele. The list of households for each Kebeles, knowing that the list did not contain any hidden order was obtained from the Kebeles leaders and it was used as a sampling frame. The study households were selected through systematic random sampling of every $(10)^{th}$ (sampling interval, K=N/n=4317/422$=10$) household to obtain a total sample of 422. When the selected households were inconvenient, the households before or after the indicated one were sampled for replacement. From those who are members of selected households and available at home during the data collection period, one individual per household was sampled by using simple random sampling techniques.

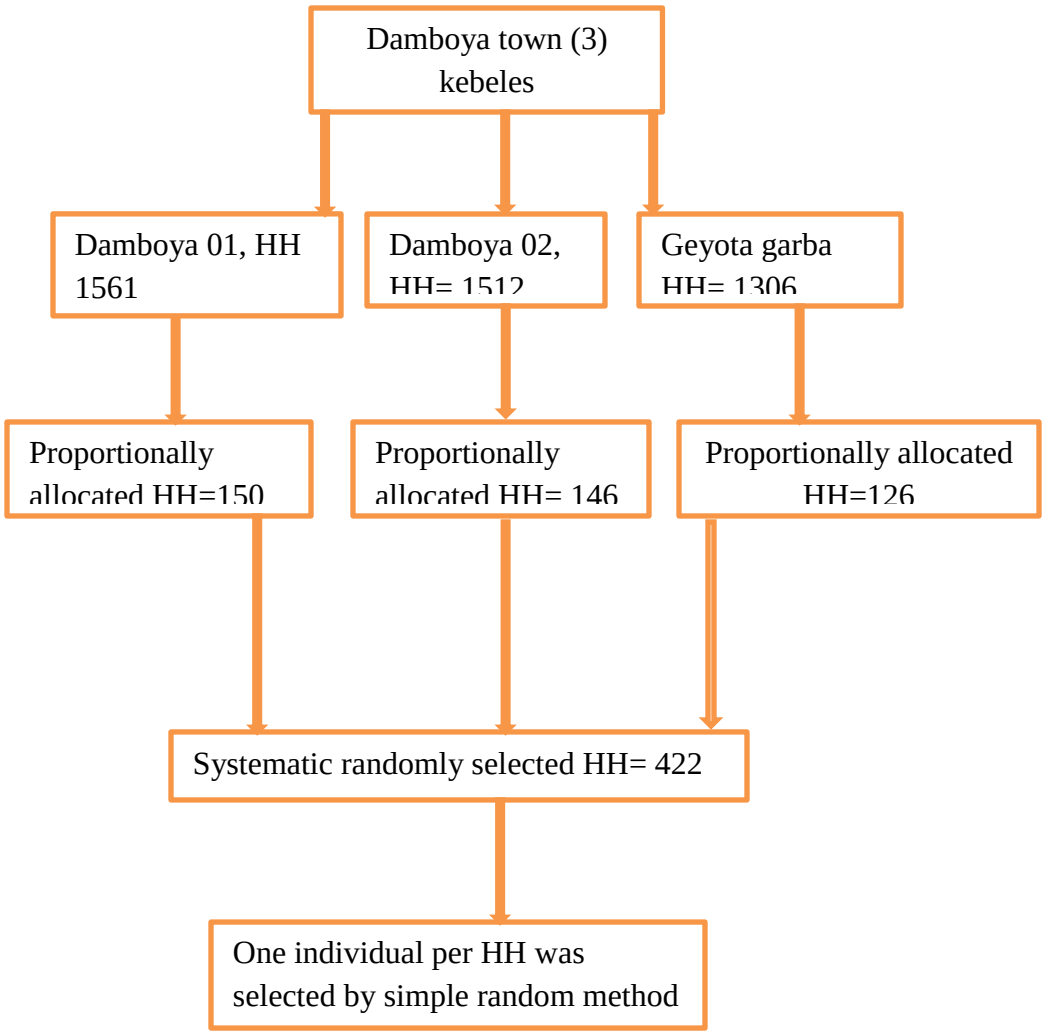


Figure 3 Schematic presentation of sampling procedure to determine the magnitude and associated risk factors of urban malaria in Damboya town, Kambata Zone, Central Ethiopia, March 7 to May 29, 2023.

4.7. Variables of the study

4.7.1. Dependent variable

- ✓ Prevalence of urban malaria

4.7.2. Independent variables

Age, sex, marital status, pregnancy, level of education, occupation, monthly income, family size, presence of stagnant water, urban agriculture or garden, house distance from nearby mosquito breeding site, availability, number, usage, and possession of ITN, the type of house wall, presence of screen on the doors and window, travel history, previous history of malaria infection, family history of malaria, presence of eaves on the wall of house, toilet facility, source of drinking water, and presence of domestic animals,

4.8. Data collection

4.8.1. Malaria-risk-factor assessment

Three trained health extension workers were employed for malaria risk factor assessment and three trained laboratory technologists were employed for blood sample collection, for conducting CareStartTM Malaria HRP2/pLDH (Pf/Pv) Combo (mRDT) test, and for microscopic examination of blood smears. Information on markers of Socioeconomic status, socio-demographic, and environmental variables that include sex, age, family size, income, pregnancy, marital status, level of education, house distance from nearby mosquito breeding site, the main material of house roof, wall, presence of eaves and opening on the wall, presence of latrines, the incidence of anti-malarial spraying in the past 12 months, possession and use, number and type of ITNs, were collected by health extension workers by using a structured and pre-tested questionnaire. Randomly selected individuals of the selected HHs present at home during the house-to-house visit were interviewed in Kambatissa, which is the local language, and those who did not understand the local language were interviewed in the Amharic language. For participants, less than 18 years old assent was obtained from parents or caretakers/guardians after explaining the study's purpose, possible risks, and benefits.

4.8.2. Parasitological survey

The presence of the malaria parasite was determined by using both malaria rapid diagnostic tests and microscopic examination of the malaria parasite. For each participant, thick and thin blood films were prepared directly from finger-prick or heel prick blood on the same slide and labeled with a unique code. The thin blood smears were fixed with methanol for 30 seconds in the field. Then, blood smears were transported to Damboya Town Health Center and stained with 10% Giemsa solution for 10 minutes. Following the standard protocols, the stained blood smears were examined by light microscope with oil immersion (100×) objective to detect malaria parasite. The results were classified qualitatively as either negative (no malaria parasite seen), or positive (hemiparasite seen) for specific *Plasmodium* species, or mixed infection. At least 100 high-power fields (100× objective) were examined before reporting a negative result. CareStartTMMalaria HRP2/pLDH (Pf/Pv) Combo test was performed according to the manufacturer's instructions. The mRDT test results were reported after 20 minutes and interpreted as negative or positive, or mixed.

4.9. Data quality assurance

To ensure the reliability and validity of the data the following activities were done just before, during, and after the actual laboratory performance. Data collectors were trained for three days on interviewing techniques, blood sample collection, process, and examination questionnaire content. Geimsa Stain were well prepared according to SOP and quality was checked by observing several stained slides for the morphology of the cells before actual work and evaluated regularly. BF was prepared for each participant; the appropriateness of questionnaires was ensured by performing a pretest on 5% of questionnaires before actual data collection. The diagnostic quality of RDT was checked by using a known positive blood sample. The rapid diagnostic test was read before microscopic examination by a laboratory technologist. A laboratory technologist who reads RDT results was blind to malaria microscopy. Microscopic examinations of thick and thin blood smears were done systematically by senior and well-trained laboratory technologists who were strictly blind to RDT results and, in case of discrepancy between microscopic readings of the two laboratory technicians, then smears were reanalyzed for a third time by another laboratory professional. At least 10% of the negative slides and all positive slides were sent to Durame General Hospital for external quality control. The SOP was strictly followed throughout the study period.

4.11. Data entry and analysis

Data were entered by Epi-Data 3.1 version whereas the analysis was conducted by using the SPSS version 25 IBM software. Descriptive statistics were used to give a clear picture of dependent and independent variables. The frequency distribution of the variables was worked out and the association between dependent and independent variables was explored by using bivariate and multivariate logistic regression analysis. Those variables associated with the outcome variable in bivariate logistic regression analysis (P-value of <0.25) were further subjected to multivariate analysis to control possible confounders. A statistically significant association was declared at a P-value of <0.05. Finally, the findings of the study were presented in text, table, and chart as appropriate.

4.12. Ethical considerations

Ethical clearance was obtained from the institutional review board (IRB) of Hawassa University, College of Medicine and Health Science, (Ref.No: IRB/205/15). A support letter was obtained from the Kambata Zone. For participants older than 18 years individual permission was obtained from each study subject after informed consent about the importance of participation in the study was described. For study participants who are less than 18 years both consent from parents/guardians and assent was taken. The data collectors explained all the necessary information that the study subjects wanted to know about the study. All cases with a history of fever in the preceding three days and/or those who had fever on examination and were positive for malaria parasite during BF examination were offered anti-malarial treatment as per national guidelines.

4.13.Result dissemination plan

After finalizing this study, the findings will be disseminated through the presentation of the findings to staff members, research presentation symposiums, and professional associations.

4. RESULTS

5.1. Socio-Demographic Characteristics of Study Participants

A total of 422 study participants were included in this study. Of this, more than half (57.6%) were females. The majority (52.6%) of the respondents were married. The study population was composed of individuals aged below 5 years 1.9%, 5-14 years age groups 14.7%, and above 15 years 83.6%. The mean age of the study participants was 29 (± 16.8sd) years with an age range of 1-92 years. About 43.8% of study participants were single and 49.3% were learned secondary school and above. The average family size was 5.4 with a range of 1 to 9. Of the total study participants Marchant, government employees, and housewives accounted for 58.8%, 20%, and 9% respectively. About 34% of the study participants had monthly incomes above 6000 ETB (Table 1).

Table 1 Socio-demographic characteristics of household respondents, in Damboya town, Kambata Zone, Central Ethiopia, March 7 to May 29, 2023 (n=422).

Variables	Category	Damboya 01 (n=150)	Damboya 02 (n=146)	G\garba (n=126)	
		N (%)	N (%)	N (%)	Total (%)
Sex	Male	54(36.0)	59(40.4)	66(52.4)	179(42.4)
	Female	96(64)	87(59.6)	60(47.6)	243(57.6)
Age	<5	7(4.7)	0	1(0.8)	8(1.9)
	5-14	11(7.3)	31(21.2)	20(15.9)	62(14.7)
	15-24	33(22)	29(19.9)	24(19.0)	86(20.9)
	25-34	40(26.7)	33(22.6)	44(34.9)	117(27.3)
	35-44	26(17.3)	17(11.6)	21(16.7)	64(15.2)
	45-55	19(12.7)	12(8.2)	9(7.1)	40(9.5)
	>55	14(9.3)	24(16.4)	7(5.6)	45(10.7)
Marital status	Single	54(36.0)	68(46.6)	63(50.0)	185(43.8)
	Married	89(59.3)	72(49.3)	61(48.4)	222 (52.6)
	Divorced	3(2.0)	1(0.7)	1(0.8)	5(1.2)
	Widowed	4(2.7)	5(3.4)	1(0.8)	10(2.4)
Pregnancy	Pregnant	15(15.5)	9(10.5)	17(28.3)	41(16.9)
	Not pregnant	82(84.5)	77(89.5)	43(71.7)	202(83.1)
Educational status	Illiterate	12(8)	12(8.2)	9(7.1)	33(7.8)
	Primary school	63(42)	56(39.1)	60(47.6)	181(42.9)
	Secondary and college	75(50)	76(52.1)	57(45.2)	208(49.3)
Occupation	Government employee	31(20.7)	21(14.4)	28(22.2)	80(19)
	Daily laborer	7(4.7)	21(14.4)	9(7.1)	37(8.8)
	Merchant	102(68)	96(65.8)	50(39.7)	248(58.8)
	Housewife	8(5.3)	6(4.1)	24(19)	38(9.0)
	Private	2(1.3)	2(1.4)	15(12)	19(5)

Monthly	≤1500	27(18)	35(24)	16(11.7)	78(18.5)
income	1501-3000	22(14.7)	24(16.4)	23(18.3)	69(16.4)
	3001-4500	30(20)	28(19.2)	11(8.7)	69(16.4)
	4501-6000	23(15.3)	24(16.4)	15(11.9)	61(14.7)
	>6000	48(32.0)	35(24)	61(48.4)	144(34.1)
Family size	≤ 3	21(14)	27(18.5)	19(15.1)	67(15.9)
	4-6	96(64)	86(58.9)	106(84.1)	288(68.2)
	≥7	33(22)	33(22.6)	1(0.8)	67(15.9)

5.2.Prevalence of malaria among study participants

The overall prevalence of malaria detected by either RDT or light microscopy was 5%(95%CI: 3.1-7.5), in the study area, where *P. vivax* accounted for 61.9%, and *P. falciparum* for 33.3%, while mixed species infection (*P.f & P.V*) accounted for 4.7%. Of the total *Plasmodium*-infected subjects, 15.7% were found at the gametocyte stage of *P. falciparum* and the remaining 57.8 and 26 % were at their early stage (ring/trophozoites stage) and mature schizont stages of both malaria parasites respectively.

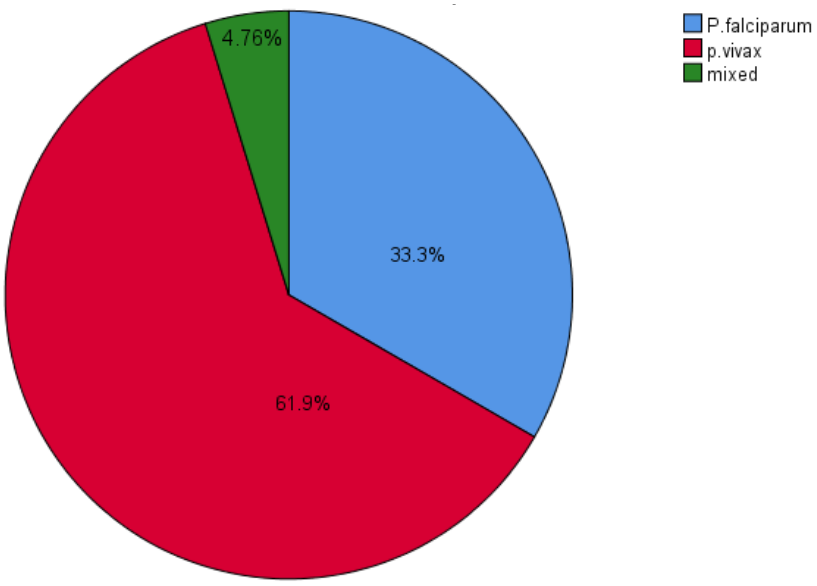


Figure 4 Relative proportions of *Plasmodium* species detected by either RDT or light microscopy in Damboya town, Kambata Zone, Central Ethiopia, March 7 to May 29, 2023.

Table 2 Malaria prevalence among study participants in Damboya town, Kambata Zone, Central Ethiopia Region, March 7 to May 29, 2023

Variables	Category	Malaria prevalence		
		Pos (%)	Neg (%)	Total (%)
Sex	Male	13(57.1)	167(41.6)	179(42.4)
	Female	8(42.9)	234(58.4)	243(57.6)
Age	<5	1(4.8)	7(1.7)	8(1.9)
	5-14	6(28.6)	56(14)	62(14.7)
	15-24	5(23.8)	81(20.2)	86(20.4)
	25-34	3(14.3)	114(28.4)	117(27.7)
	35-44	3(14.3)	61(15.2)	64(15.2)
	45-55	1(54.8)	39(9.7)	40(9.5)
	>55	2(9.5)	43(10.7)	45(10.7)
Marital status	Single	10(47.)	175(43.6)	185(43.8)
	Married	9(42.9)	213(53.1)	222(52.6)
	Divorced	1(4.8)	4(1.0)	5(1.2)
	Widowed	1(4.8)	9(2.2)	10(2.4)
Pregnancy	Pregnant	2(22.2)	39(16.7)	41(16.9)
	Not pregnant	7(77.8)	195(83.3)	202(83.1)
Educational status	No formal education	3(16.7)	27(6.7)	30(7.1)
	Primary school	11(50)	168(42.1)	179(42.4)
	Secondary and college	7(33.3)	206(52.1)	213(50.5)
Occupation	Government employee	2(1.1)	64(15.8)	66(15.6)
	Daily laborer	3(16.7)	34(8.4)	37(8.8)
	Merchant	12(55.6)	230(57.4)	242(57.3)
	Housewife	3(11.1)	27(6.9)	30(7.1)
	Private	1(5.6)	46(11.4)	47(11.1)
Monthly income	<1500	10(47.6)	58(13.5)	68(16)
	1500-3000	1(9.5)	69(17)	70(16.6)
	3001-4500	3(13.3)	63(15.5)	66(14.4)
	4501-6000	1(4.8)	72(15.2)	73(14.7)
	>6000	6(23.8)	139(34.9)	145(34.4)
Family size	≤ 3	1(4.8)	66(16.5)	67(15.9)
	4-6	16(76.2)	272(67.8)	28(68.2)
	≥7	4(19)	63(15.7)	67(15.9)
Presence of stagnant water	Yes	8(38.1)	82(20.4)	90(21.3)
	No	13(61.9)	319(79.6)	332(78.7)

Distance of house from the breeding site	<1km	7(33.3)	85(21.2)	92(21.8)
	>2km	14(66.7)	316(78.8)	330(78.2)
Number of ITNs	One	6(75)	155(15.5)	161(73)
	Two	2(47)	47(22)	49(22)
	More than two	0(0)	12(5.6)	12(5.4)
Usage of ITN in the home	Yes	8(100)	194(90.7)	202(91)
	No	0(16.7)	20(9.3)	20(9)
possession of ITN	Whole family	0(0)	60(31.4)	60(30.3)
	Some family member	7(100)	131(67)	138(70.5)
Type of house wall	Mud plastered	18(90.5)	320(79.8)	339(80.3)
	Stonewalled	2(4.8)	75(18.7)	76(18)
	Break wall	1(4.8)	6(1.5)	76(18)
The presence of screens on windows and doors	Yes	9(42.9)	317(79)	326(77.3)
	No	12(57)	84(20.9)	96(22.7)
The surface of the wall of the house	Very smooth	7(33)	182(45)	189(45)
	Smooth	6(28.6)	153(38)	159(38)
	Rough	7(33)	61(15)	68(16)
	Very rough	1(4.8)	5(1.2)	6(1.5)
Traveling history	Yes	9(42.9)	68(17)	77(18.2)
	No	12(57.1)	333(83)	345(81.8)
previous history of malaria	Ye	2(9.5)	25(6)	27(6.4)
	No	19(90.5)	376(93.8)	395(94)
Family history of malaria	Yes	1(4.8)	27(6.7)	28(6.6)
	No	20(95)	374(93)	394(93.4)
The presence of holes that allow entry of mosquitoes	Yes	16(71.4)	124(31.2)	140(33.3)
	No	5(28.6)	277(68.8)	282(66.8)
Availability of ITNs	Yes	14(67)	184(46.6	201(47.6)
	No	7(33)	217 (53))	221(52)

Note, Pos = positive, Neg = Negative

5.3.Associated factors of malaria

5.3.1. Bivariate and multivariate logistic Regression of associated factors for malaria

Bivariate logistic regression analysis was performed and variables with p-value < 0.25 were selected as candidate variables for multivariate logistic regression analysis. Twelve variables (Ses, educational status, monthly incme, family size, presence of stagnant water, distance of house from a breeding site, type of house wall, The presence of screens on window, surface of the wall of the house, traveling history, presence of any holes on the wall of house and availability of ITN) were selected and integrated into the multivariate logistic regression model for controlling confounding variables.

In multivariate logistic regression analysis only five (presence of potential mosquito breeding sites; the presence of any holes on the wall of house , travel history; monthly income, and availability of ITN variables) were significantly associated with malaria infection in this study (P < 0.05). Study subjects who lived in areas where stagnant water was available were 3.88 times more likely to get malaria infection compared to those who lived away from stagnant water. Individuals who did not use ITN were about 3.24 times more likely to be infected with malaria (than those who used it daily. People who live in houses that have eaves that allow entry of mosquitoes were 4.22 times more likely to be infected with malaria infection compared to those who live in houses without eaves. Individuals who have a travel history within the last two or three weeks before the data collection were about 3.78 times more likely to be infected with malaria than those who do not have a travel history to the malaria-endemic area. Study participants who have a monthly income of less than 1500 ETB were about 5.11 times more likely to be infected with malaria than those who earn a monthly income of more than 6000 ETB (Table 3). Even though there was no statistically significant association observed between the prevalence of malaria and sex, more cases were detected among males.

Table 3 Bivariate and multivariate logistic regression analysis of factors associated with malaria infection in Damboya town, Kambata Zone, Central Ethiopia, March 7 to May 29, 2023 (n = 422).

Variables	Category	Bivariate analysis		Multivariate analysis	
		COR(95%CI)	P-value	AOR(95%CI)	P-value
Sex	Female	2.3(0.99-5.67)	0.071	1.42(0.45-4.41)	0.550
	Male	1.000		1.000	
Educational status	No formal education	3.27(0.79-13.40)	0.100	3.39(0.56-20.69)	0.184
	Primary school	1.93(0.73-5.08)	0.185	1.88(0.59-5.99)	0.280
	Secondary and college	1.000		1.000	
Monthly income	≤1500	3.99(1.39-15.50)	0.010	5.11(1.27-20.58)	**0.022**
	1501-3000	0.34(0.04-2.84)	0.317	0.15(0.01-2.33)	0.176
	3001-4500	1.10(0.27-4.55)	0.89	0.96(0.19-5.11)	0.977
	4501-6000	0.32(0.04-2.72)	0.298	0.33(0.03-3.27)	0.346
	>6000	1.000		1.000	
Family size	≤3	1.000		1.000	
	4-6	3.88(0.51-29.80)	0.192	4.88(0.53-45.32)	0.166
	≥7	4.19(0.45-38.52)	0.206	2.64(0.22-31.26)	0.441
Presence of stagnant water	Yes	2.39(0.96-5.97)	0.061	3.88(1.14-13.22)	**0.030**
	No	1.000		1.000	
Distance of house from a breeding site	≤1km	0.54(0.21-1.37)	0.195	1.46(0.33-6.35)	0.61
	>1km	1.000		1.000	
Type of house wall	Mud plastered	0.35(0.04-3.11)	0.351	4.73(0.13-166)	0.392
	Stonewalled	0.08(0.00-1.44)	0.087	1.63(0.04-72.09)	0.799
	Break wall	1.000		1.000	
The presence of screens on window	Yes	1.000		1.000	
	No	5.03(2.00-12.34)	<0.000	3.25(0.91-11.67)	0.071

The surface of the wall of the house	Very smooth	1.000		1.000	
	Smooth	1.02(0.34-3.09)	0.973	0.36(0.02-9.95)	0.551
	Rough	2.98(1.00-8.85)	0.049	0.33(0.02-2.33)	0.491
	Very rough	5.2(0.53-50.63)	0.156	0.31(0.02-6.96)	0.462
Traveling history	Yes	2.82(1.07-7.43)	0.049	3.88(1.14-13.22)	**0.036**
	No	1.00		1.00	
The presence of holes in the wall	Yes	7.12(2.56-19.95)	<0.000	4.22(1.17-15.0)	**0.027**
	No	1.00		1.000	
Availability of ITNs	Yes	1.000		1.000	
	No	2.29(0.91-5.79)	0.08	3.24(1.01-10.41)	**0.048**

6. DISCUSSIONS

About 300 million people currently live in urban areas in Africa and two-thirds of them are at risk of malaria. Ethiopia towns are also characterized by poor housing, lack of proper sanitation, poor drainage of surface water, weak health services, and widespread economic disparity, which independently or together facilitate urban malaria transmission (Adugna, Wale, and Nibret, 2022). The findings of this investigation showed that 5% of people had malaria parasites in study area. *P. vivax* makes up 61.9%, *P. falciparum* 33.3%, and mixed infection only makes up 4.8% of the total. In this study the prevalence of malaria was influenced by the existence of eaves on the wall, the presence of standing water, the lack of ITN, income, and travel history.

In the present study, the overall prevalence of malaria in Damboya town was 5% (95% CI=3.1–7.5). The finding was comparable to a study conducted on several regions of Ethiopia, 6.1% in the Benna Tsemay district of pastoralist community, Southern Ethiopia (Debo and Kassa, 2016), 5.2% in Jimma town (Abeba Alemu, 2011), and 5.3% in Gonder (Tilaye, Tesfaye, Deressa, 2007) and 4.7 % in Maygaba town in Wolikait district. But this study's finding was much lower than some studies in Ethiopia Batu town at 17.13% (Hassen and Dinka, 2022), Olanchity town at 27.8% (Yosef Gudeta, 2022), Chichu and Wonago town at 28.1% (Molla *et al.* 2016), Mizan Aman town 21.1% (Duguma *et al.*, 2022). A higher prevalence of malaria was also reported in other countries, example 12% prevalence was reported in Tanzania (Kadete, L Nyange, A Molteni, 2006), and 26.5% in the northern part of Ghana (Tiedje *et al.*, 2017). This difference might be attributed to differences in geographical location relative to the present study area as the above-mentioned area is highly malarious and the population is continuously exposed to malaria this might lead to the development of immunity which results in asymptomatic malaria (Abebaw *et al.*, 2022). Another possible reason might be the difference in study design, quality of houses, nature of population, sample size, and study period. Malaria prevalence varies from season to season even within the same area and the large occurrence of malaria in Tanzania and Ghana might be due to geographical variation and spatial hetrogeniety (Ngarakana-Gwasira *et al.*, 2016). In contrast, the finding of this study was higher than that of a study conducted in a Butagira area (0.9%) (Woyessa *et al.*, 2012) and Nazareth town (2.8%). This might be due to difference in microclimatic condition of the area,capacity of health system, strength of malaria control and prevention programe.

In this study, P.vivax outnumbered *P. falciparum* with a relative percentage of 61.9% to 33.3%, respectively. This finding was supported by a study conducted in different areas of Ethiopia (Abeba Alemu, 2011; Woyessa *et al.*, 2012; Ayalew *et al.*, 2016; Delil *et al.*,2016; Molla Belete and Bedane Roro, 2016; Tadesse, Fogarty and Deressa, 2017). In contrast, *P. falciparum* outnumbered *P. vivax* in study reports from different regions of Ethiopia (Worku *et al.*, 2014; Debo and Kassa, 2016; Abossie *et al.*, 2017; Debash *et al.*, 2023). From outside of Ethiopia, *P. falciparum* over dominated *P. vivax* in Quibdo town, Brazil (Osorio *et al.*,2004). This variation in the occurrence of *plasmodium* species might be due to differences in the epidemiology of *Plasmodium* species from one area to another, most likely as a result of altitudinal and climatic variations (Daygena, Massebo and Lindtjørn, 2017).

In the current investigation, there was a significant association between the presence of malaria and the unavailability of ITN at home. In our study, the likelihood of contracting malaria was 3.24 times higher in people who did not have ITN than those who had. This finding is supported by some studies conducted in Ethiopia (Delil *et al.*, 2016; Andargachew *et al.*, 2022). According to numerous studies the presence and use of ITN prevent mosquitoes by trapping and killing them (Okumu and Moore, 2011). However, studies done in African regions found that the use of ITNs did not significantly reduce malaria morbidity and mortality (Pardo *et al.*, 2006). In our study, a difference in malaria prevalence was found between ITN users and non-users. This was supported by another study that found that the mere availability of ITNs in households does not guarantee that people will be protected from malaria morbidity unless they are appropriately used (Tilaye, Tesfaye, Deressa, 2007). Even though there was no statistically significant association between family size and malaria prevalence more cases were observed in family size of 4-6 individuals. This may be due to the uneven distribution of ITN to family members, and the inability to cover treatment costs (Scates *et al.*, 2020). Even though there was no statistically significant association between malaria infection and education more cases were observed among those who do not have formal education. Education makes people read and write, which could help individuals to be aware of malaria, its transmission, and prevention ways, eventually reduces odds of getting malaria infection (Bauch *et al.*, 2013).

The results of this investigation demonstrated a high association between malaria infection and the existence of eaves on the house. People who live in homes with eaves that allow mosquitoes to

enter their homes were 4.22 more likely to contract malaria than people who live in homes without eaves on the wall. A study conducted by (Oesterhol *et al.*, 2006) revealed that those who reside in homes with open eaves and no ceilings have a greater risk of contracting *Plasmodium*. The likelihood of receiving a mosquito bite indoors is increased by the existence of eaves (s), which may allow malaria vectors to enter homes. Even though there was no statistically significant association, more cases of malaria were observed among individuals who lived in mud-plastered houses in this study. Living in a mud-plastered house was linked to a much higher risk of malaria compared to stonewalled or break-walled houses (Dlamini *et al.*, 2017).

In our investigation, an environmental factor with a positive association with malaria prevalence was the presence of stagnant water near the home. The prevalence was 3.88 times higher in those who live around stagnant water than those who live far away. This was supported by a study conducted in the district of Northwest Ethiopia (Abebaw *et al.*, 2022). A study by ITNs in the Gambia found an inverse relationship between the number of mosquitoes in the village and the distance of settlement from the river, further supporting the idea that the relationship between malaria vector density and the distance of residence from a water body (Mills *et al.*, 1993). Study in Kole district, Uganda revealed that dwellings were surrounded by water in open, abandoned containers, as well as stagnant water from flooding, closed drainage systems, house washes, tires, parking areas, and construction, that acted as breeding grounds for mosquitoes (Nabatanzi *et al.*, 2022).

The result of this study also demonstrated that there was a risk of contracting malaria while traveling from places with lower malaria frequency to areas where it is endemic. In this study, individuals with a history of travel were 3.78 times more likely to contract malaria than those without a history of travel. Urban people have a lower level of immunity against malaria, making them more susceptible to the disease when exposed. Due to reduced immunity, urban individuals are more susceptible to developing severe cases of malaria when they visit rural areas (Larson *et al.*, 2021). Due to their lowered immunity, city dwellers are more susceptible to contracting malaria when visiting rural areas as well as when malaria-infected people visit the city (Arinaitwe *et al.*, 2020). Studies on urban populations in Burkina Faso, Cote d'Ivoire, and Zambia all reveal a strong association between malaria infection and a recent trip to a rural area, supporting this hypothesis (Ahmed *et al.*,2020). Another study also showed that traveling significantly increases the chance of

developing malaria, particularly when traveling to urban areas, rural areas, or locations with higher transmission rates than the originating location (Abdalal *et al.*,2023). According to the study, people will have less access to healthcare facilities due to migratory activities in the highland periphery, which will raise the risk of *Plasmodium* infection (Pindolia *et al.*, 2013). A study in Brazil also found increased odds of *Plasmodium* infection among adults with a travel history to malaria-endemic areas (Johansen and Priscila, 2020).

In this study, income level showed a positive association with malaria prevalence. Individuals who had monthly incomes less than 1500 ETB were 5.11 times more likely to contract malaria than those who had a high monthly income greater than 6000 ETB. This finding was supported by different studies (Omer *et al.*, 2010; Gahutu *et al.*, 2011; Degarege *et al.*,2019). Adults with lower socioeconomic positions had an increased risk of *Plasmodium* infection, according to a study conducted in Ethiopia (Abeba Alemu, 2011). A different study conducted in Ethiopia, however, found an association between malaria prevalence and the level of yearly household income. The ability of people to employ the commodities and services that are offered to treat malaria may also depend on their financial situation. For instance, the poorest people might not have the money to pay for transportation, doctor visits, or medication when they are ill. People might not seek treatment as a result (Varela *et al.*, 2019). According to a study conducted in Tanzania, children from wealthy homes are more likely than those from poorer families to receive antimalarial medications (Ge, *et al.*, 2023). People with lower socioeconomic status in urban areas have a significantly increased risk of getting malaria (Larson *et al.*, 2021). Urban socioeconomic characteristics, as demonstrated in Libreville, contribute to an increase in transmission in impoverished regions with slum-like circumstances (Mourou *et al.*,2012).

7. Conclusions and recommendations

7.1. Conclusions

In this study, the overall prevalence estimate of malaria was moderate relative to other studies done in different areas of the country. This indicates that malaria is still a public health problem in the study area. Among *Plasmodium* species, *Plasmodium vivax* is found to be the highest prevalent in the study area. The prevalence was strongly associated with the presence of potential mosquito breeding sites, the presence of eaves on the wall, travel history, monthly income, and

availability of ITN. Malaria is affecting significant proportions of the urban settlers and human activities nevertheless play an important role in bringing the mosquito breeding sites closer to residences. Therefore, in endemic malaria locations, knowing the prevalence of malaria and its associated risk factors in the urban setting is important to deciding on appropriate malaria intervention approaches. Improved access to all malaria interventions is needed to interrupt the transmission in the community of urban settings, which helps to achieve the malaria control and elimination programs.

7.2. Recommendations

Based on the findings, provision of early diagnosis and treatiment of malaria carriers during the minor transmission seasons is also very important to prevent reservoirs for the major transmission period. It would be better to conducte further prevalence studies by using highly sensitive and specific techniques such as PCR. During the screening of malaria in the community, both asymptomatic and symptomatic malaria should be considered in the implementation of the control/elimination Programme such that the effectiveness of control strategies can be monitored by reliable metrics. It would be better to conduct an entomological study which will help to localize the malaria transmission in urban settings either it was endogenous or imported cases.

The finding of this study showed an increased prevalence of malaria with a decrease in household income status thus we would like to reccomend regional and local health sectors and any NGO to support those people with low income status by providing malaria preventive materials like ITN and improving their house conditions. In the study area, none of the houses were sprayed with IRS. Thus, in areas where the option of environmental manipulations may be difficult, especially after the major rainy season, it would be better to recommend local health sectors to apply IRS before the rainy season to prevent and control epidemic outbreaks. Drainage of Anopheles breeding sites, vector control ,expanded personal protection and effective diagnosis and treatement would be recommended to prevent malaria incidence. Also, modification of houses, such as screening of doors and windows to prevent mosquito entry, sanitation and health education for community in order to improve their environmenta would be recommended to minimize morbidity and mortality of malaria in the study area.

In this study, individuals aged 5–14 years (highly vulnerable age groups) were identified as an important target for future malaria control strategies because more cases were detected among this age group. Thus, as under 5 children and pregnant women, it could be better to give due emphasis to prompt diagnosis and effective treatment as well as increased use rate of ITN for those individuals aged 5 to 14 years old. It would be better to use malaria prophylaxis on a certain trip or from malaria non-endemic or low transmission area to malaria-endemic areas for certain purposes, if they sleep there it is better to use ITN.

8. Strengths and limitations

8.1. Strengths

Simple random sampling techniques were used to determine a representative sample to infer about the source population.

Malaria RDT and light microscopy were used to determine malaria prevalence

A community-based study design helped in active case detection.

8.2. Limitations:

As with any cross-sectional study, it is difficult to establish a causal relationship in this study.

The issues of drug resistance and climatic factors that can contribute to the occurrence of malaria are not addressed in this study. The study was conducted during the season when the parasitological yield is expected to be low.

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ANNEXES

Annex1.Blood smear preparation, staining, and microscopic examination procedures

Blood smear preparation and staining were performed on-site during home to the home visit and the smear was transported by slide box to Damboya Health Center and stained there. The lobe of the finger or heel of an infant was cleaned using a swap moistened with 70% V/V alcohol using a sterile lancet, the finger or heel was priced and squeezed gently to obtain a large drop of blood. The first drop was discarded. Using a completely clean grease-free microscope slide and preferably a malaria slide card, a small drop of blood was added to the center of the slide and a larger drop about 1.5mm near the labeling end. Immediately the thin film was spread using a smooth-edged slide spreader. Without delay, the large drop of blood was spread to make a thick smear and covered evenly on an area of about 15x15 mm2. Using a black lead pencil, the slide was labeled with the date and the participant code number. The blood was allowed to air-dry with the slide in a horizontal position and placed in a state place. The slide was placed horizontally on a staining rack. A small drop of absolute methanol or ethanol was applied on the thin film, making sure the alcohol did not touch the thick film as this will prevent lysis of the red blood cells and make the thick film readable and the thin film was allowed to be fixed for one to two minutes. Immediately before use, the Giemsa stain was diluted as required stain 10% solution (1 part of Giemsa stock solution to 9 parts of distilled water) for ten minutes of staining. The diluted stain was poured into the shallow tray, or Coplin jar, or stained through. The slides were placed face downwards in a shallow tray supported on the two rods, in a coupling jar, or a staining jar for 10 minutes. The slide from the staining container was removed and washed using clean water (need not be distilled or buffered). The back of each slide was wiped and placed on a draining rack for the preparation to air dry. The thin smears were fixed with methanol for 3 to 5 minutes (WHO, 2016; Hopkins, 2019). The smears were placed in the slide box and transported to the Damboya town Health center for microscopic examination.

Examining thick and thin blood films

Giemsa-stained blood film was placed to be examined on the microscope stage, with the label to the left. Position the thick film in line with the 10x objective lens. Switch on the microscope, adjust the light source optimally, and find the focus by looking through the ocular and the 10x objective. Scan

the blood film for other parasites and blood elements. Select a part of the film that is well stained and has evenly distributed white blood cells. A drop of immersion oil was added to the thick film. Do not allow the 40x objective to touch the oil. Switch the 100x oil immersion objective over the selected portion of the thick film. Examine the slide systematically. Start at the top left of the film and begin at the periphery of the field, then move horizontally to the right, field by field. When the other end of the film is reached, move the slide slightly downwards, then to the left, field by field, and so forth. For efficient examination, continuously focus and refocus with fine adjustments throughout the examination of each field. Continue to examine the slide for 100x or oil immersion fields. Move the blood film by one high-power field each time, following the pattern. Use the fine adjustment to focus. A minimum of 100 high-power fields must be examined before a thick film can be declared as having "no malaria parasites seen". If possible, the whole thick film should be scanned. The thin blood film should always be examined to identify parasite species definitively. The thin film allows visualization of parasite and red cell morphology, unlike the thick film. Examine the feathery end or edge of the thin film. Identify and record all species and stages observed in the malaria microscopy blood register (WHO, 2016).

Annex 2.Principles and procedures of CareStartTM Malaria HRP2/pLDH (Pf/Pv) Combo (RDT) test

Principles: CareStartTM Malaria HRP2/pLDH (Pf/Pv) Combo (RDT) test detects specific antigens (proteins) produced by malaria parasites in the blood of infected individuals. Some RDTs can detect only one species while others detect multiple species *(P. falciparum* and *P. vivax*). Blood for the test is commonly obtained from a finger prick and heel prick in the case of children.

RDTs are lateral flow immunochromatographic 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.

Procedures: The first step of the test procedure involves adding of whool blood to the samle well and the second step is adding of assay buffer to the buffer well. This ruptures the red blood cells, releasing more parasite protein. A 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. An 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. 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. If the antigen is present, some labeled antibody-antigen complex will be trapped and accumulate on the test line. The 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. The result will be read in 5 to 20 minutes the appearance of two colored lines indicates a positive and the appearance of the only control line in control indicates a negative result. 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.

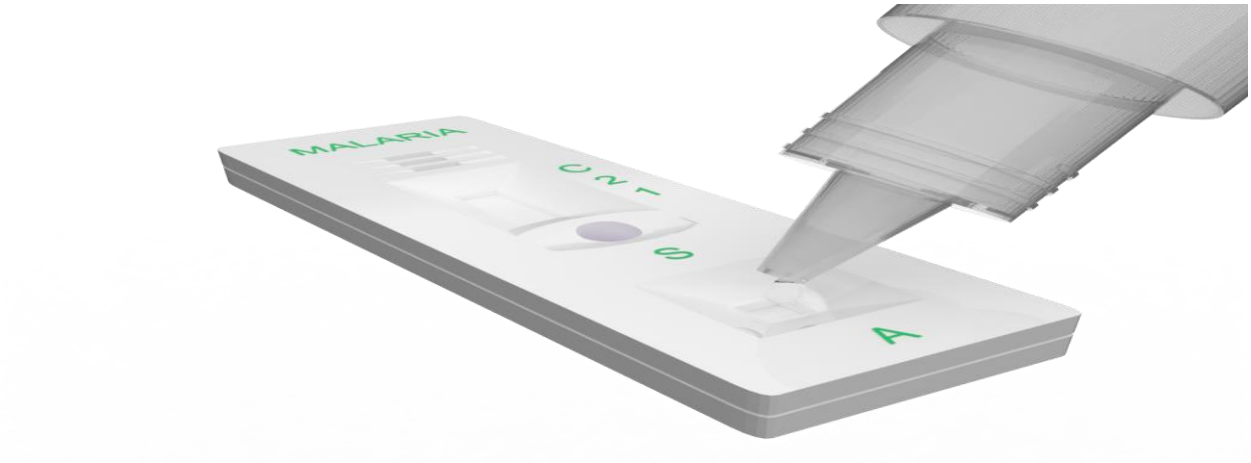
Negative: The presence of only a control band indicates a negative result for *P*. *falciparum* malaria. If the RDT result is negative, alternative causes of fever should be investigated and treated appropriately. Note: Do not read the results before or after the set time. Don't treat any fever as malaria despite a negative result.

Positive: The presence of both a control band and a test band indicates a positive result. Refer to the manufacturer's instructions to read positive results.

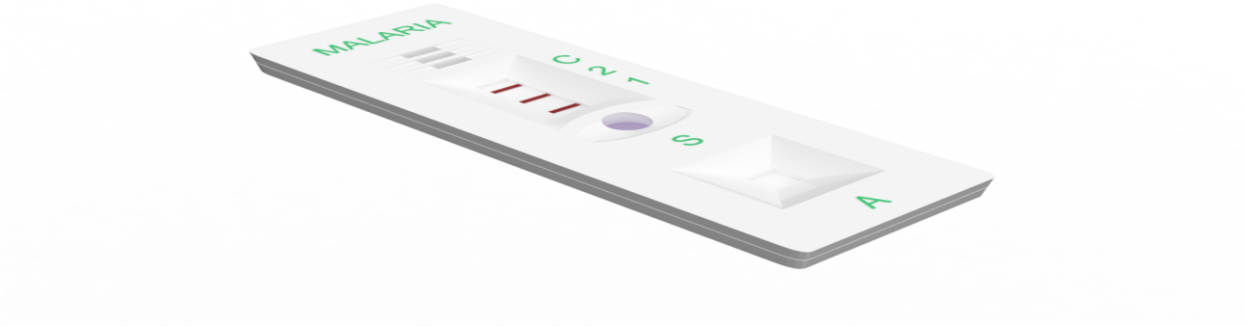
Invalid: If the test does not show the control band, even if there is a test band, the test is invalid. Perform another RDT. Refer to the "RDT Provider job-aid" for pictures of negative, positive, and invalid results (Obeagu, UO, and IS, 2018).



Step one: Add 5 micr litr of whool blood



Step two: Add of buffer in to the buffer



Sstep three: Read result after 20 minutes

Figure 5. Procedure of malaria rapid diagnostic test

Annex 3. Materials and reagents

Microscope, structured questioner, RDT, lead pencil, microscopic a slide blood lancet, glove, gauze, soup, cotton, alcohol, staining jar, distilled water, oil immersion, Geimssa stock solution, absolute methanol, tissue paper, lenses cleanser.

Annex4. English informed consent/assent form

Dear participants!

My name is Biruk Mulachew and I am an MSc student of medical parasitology at the School of Medical Laboratory Sciences, College of Medicine and Health Sciences, Hawassa University (HU). I am here to study "the magnitude of urban malaria and associated risk factors among communities of Damboya town, for my MSc Thesis.

l. Participant information sheet

First of all, we want to express our appreciation for your cooperation and permission to participate in this study. Please read or listen when the study's general information is read aloud to you. Please feel free to ask any questions you may have about the study

Aim of the study: This study aims to determine the magnitude of urban malaria and associated risk factors in Damboya town, Kambata Tambaro zone, southern Ethiopia

Procedure: With your consent, we will enquire about your background, your daily activities, your employment history, and in particular your travel and mosquito bite experiences. For this work, we lightly lance your finger and take a drop of blood. The blood sample will assist in determining whether or not you have malaria. With this blood sample, no other diseases will be examined.

Risks and complications: Your participation is not anticipated to pose any risks. A single drop of blood from your finger will be drawn. You might experience some slight discomfort while the sample is being collected, but no major pain is caused.

Confidentiality and Withdrawal rights: No sensitive questions on your social desirability will be asked of you, but any information gathered in connection with this study that can be linked to you will be kept private. By using their code number, interested participants can get their lab results. The data that is gathered about you will be numeric-coded. No personal information will be shared with a third party or be included in any study report. Your participation in this study is entirely voluntary, and if you feel uncomfortable with any of the questions, you are free to skip them. You are free to decline to take part in the study or to revoke your permission at any time.

Assurance of Principal Investigator: I put my signature below to confirm that I take over the responsibility for the scientific ethical and technical conduct of the research and the provision of progress reports for all stakeholders of the research.

Biruk Mulachew (Principal investigator) Signature:_____ Date: _____

Note: You are welcome to contact the principal investigator (PI) at the following addresses with any queries you may have about this study at any time.

Principal investigator address: Biruk Mulachew: School of Medical Laboratory Sciences, College of Medicine and Health Sciences, Hawassa University, Hawassa, Ethiopia,

Email:birukmulachew2021@gmail.com

Cell Phone: +251916738589

We would like to thank you for your time.

Are you willing to participate in the study?

☐ Yes, I am willing to participate in the study.

☐ No, I do not wish to participate in the study.

Name _____ signature_____ date _____

Annex 5.Amharic informed consent/assent form

ውድ ተሳታፊዎች!

ስሜ ብሩክ ሙላቸዉ እባላለሁ። በሀዋሳ ዩኒቨርሲቲ የህክምና እና ጤና ሳይንስ ኮሌጅ የህክምና ላብራቶሪ ሳይንስ ትምህርት ቤት የሜዲካል ፓራሲቶሎጂ የሁለተኛ ድግሪ ተማሪ ሲሆን በአሁኑ ሰአት በደቡብ ኢትዮጵያ ***ክምባታ ዞን በ ዳምቦያ*** ከተማ የወባ በሽታ መጠን እና በተያያዥ የበሽታዉ መንስኤዎች ላይ ጥናት እያካሄደን ነው::

I. **የተሳታፊ መረጃ ወረቀት**

በመጀመሪያ በዚህ ጥናት ውስጥ ለመሳተፍ ለምታደርጉት ትብብር እና ፈቃድ በቅድሚያ ልናመሰግናችሁ እንወዳለን። እባክዎን ስለ ጥናቱ አጠቃላይ መረጃ ያንብቡ ወይም ሲነበብ ያዳምጡ። ጥናቱን በተመለከተ ማንኛውም ጥያቄ ካለዎት እባክዎን በነፃነት ይጠይቁ።

የጥናቱ ዓላማ፡- የዚህ ጥናት ዓላማ **በማዕከላዊ** ኢትዮጵያ ***ክምባታ ዞን በ ዳምቦያ*** ከተማ ህብረተሰብ መካከል ያለውን የከተማ ወባ እና ተያያዥ አጋላጭስጋት ለመለየት ነው።

ሂደት፡- በእርስዎ ፍቃድ፣ ስለ ታሪክዎ፣ ስለ ኑሮዎ ፣ስለ ስራዎ እና በተለይም ስለ ትንኝ ንክሻ እና የጉዞ ታሪክ ተከታታይ ጥያቄዎች እንጠይቅዎታለን። ጣትዎን በጥሩ መርፌ በትንሹ እንወጋው እና ለዚህ ስራ የደም ጠብታ እንወስዳለን. የደም ናሙናው ወባ እንዳለባችሁ ወይም እንደሌለ ለማወቅ ይረዳል። በዚህ የደም ናሙና ለሌላ በሽታዎች አንመረምርም።

አደጋዎች እና ውስብስቦች፡ በእርስዎ ተሳትፎ ላይ ምንም የሚጠበቁ አደጋዎች የሉም። ከጣትዎ የደም ናሙና አንድ ጊዜ ይወሰዳል. ናሙና በሚሰበሰብበት ጊዜ ትንሽ ምቾት ላይሰማዎት ይችላል ነገር ግን ይህ ከባድ ህመም አያስከትልም.

ምስጢራዊነት እና የመውጣት መብቶች፡ ከማህበራዊ ፍላጎትዎ ጋር በተያያዘ የሚጠየቁት ምንም አይነት ጥንቃቄ የተሞላበት ጉዳይ የለም ነገርግን ከዚህ ጥናት ጋር በተገናኘ የተገኘ እና ከእርስዎ ጋር ሊታወቅ የሚችል

ማንኛውም መረጃ ሚስጥራዊ ሆኖ ይቆያል። ፍላጎት ያላቸው ተሳታፊዎች ኮድ ቁጥራቸውን በመጠቀም የራሳቸውን የላብራቶሪ ውጤት ማምጣት ይችላሉ። ስለእርስዎ የተሰበሰበው መረጃ ቁጥሮችን በመጠቀም ኮድ ይደረጋል. ምንም የግል መረጃ ለሶስተኛ ወገን አይገለጽም ወይም በዚህ ጥናት ውስጥ በማንኛውም ዘገባ ላይ አይታይም። በዚህ ጥናት ውስጥ ያለዎት ተሳትፎ በፈቃደኝነት ብቻ ነው እና በማንኛውም ጊዜ ተሳትፎውን ማቆም ይችላሉ ወይም ምቾት ከተሰማዎት አንዳንድ ጥያቄዎችን ለመመለስ እምቢ ማለት ይችላሉ። በጥናቱ ላይ ለመሳተፍ ለመቃወም ነፃ ነዎት ወይም በማንኛውም ጊዜ ፈቃድዎን መሰረዝ ይችላሉ ፣ ምክንያቶች ሳይሰጡ እና ይህ ምንም ዓይነት ቅጣት ወይም ጥቅማጥቅሞችን ማጣት አያካትትም። ካልተመቻችሁ፣ እባክዎን በማንኛውም የጥናት ደረጃ ለማቆም ነፃነት ይሰማዎ

የዋና መርማሪ ማረጋገጫ፡ ለምርምር ፕሮጀክቱ ሳይንሳዊ ስነ-ምግባር እና ቴክኒካል ስነምግባር እና ለምርምር ፕሮጀክቱ ባለድርሻ አካላት የሂደት ሪፖርቶችን ለማቅረብ ሀላፊነቴን እንደምወስድ ለማረጋገጥ ፊርማዬን ከዚህ በታች አስቀምጫለሁ።

ብሩክ ሙላቸዉ (ዋና መርማሪ) ፊርማ፡_____ ቀን፡ _____

ማሳሰቢያ፡- ይህንን ጥናት በተመለከተ ማንኛቸውም ጥያቄዎች ካሉዎት፣ በጥናቱ ጊዜ ውስጥ በማንኛውም ጊዜ ወይም በማንኛውም ጊዜ በሚከተሉት አድራሻዎች PI ን በማነጋገር ለመጠየቅ ነፃነት ይሰማዎ።

ዋና መርማሪ አድራሻ፡- ብሩክ ሙላቸው፡ የሜዲካል ላብራቶሪ ሳይንስ ትምህርት ቤት፣ የህክምና እና ጤና ሳይንስ ኮላጅ፣ ሀዋሳ ዩኒቨርሲቲ፣ ሀዋሳ፣ ኢትዮጵያ

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l. Informed consent

The goal of the study, "magnitude of urban malaria and its associated risk factors among communities of Damboya Town, Kambata zone, central Ethiopia region," has been explained to me. Additionally, I am informed that the questionnaire's contents must all be kept private. In addition, I have been fully informed of my choice to refuse information, decline participation, and withdraw from the study at any time, and none of these decisions will in any way affect how I am treated overall. As a result, fully aware of the circumstances, I consent to provide all required data and a sample for lab testing. I've had the chance to inquire about the project and have done it in a way that has satisfied me.

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

Consent form for parents/guardians: English version

The information above has either been read to me or I have read it myself. I was allowed to ask questions, and the answers I received satisfied me. I freely agree that my child will take part in this study as long as he or she grants permission for a blood sample to be taken and agrees to participate in the study. I am aware that I have the right to withdraw my child from the study at any time

Assent form for children: English version: The information above has either been read to me or I have read it myself. I was allowed to ask questions, and the answers I received satisfied me. I freely agree that my child will take part in this study as long as he or she grants permission for a blood sample to be taken and agrees to participate in the study. I am aware that I have the right to withdraw my child from the study at any time

Participant's name _____Signature_____ Date_____

Child Name (code)_____Parents/guardians signature _____ Date_____

Witness name_____ Signature_____Date_____

Investigator name_____Signature_____ Date_____

English version questioner

1. Date:_____/_____/2015E.C
2. Respondent Code:_____/_____
3. Respondent's kebele: _____

Name of data collector _____Sign_____

Instructions: - Please read each question to the respondent clearly and slowly. Then, circle the number of choices (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	Options to be answered	Skip to
4	What is your gender?	_____(Age in years)	
5	How old are you?	1. Male 2. Female	
6	What is your Marital status?	1. Single 2. Married 3. Divorced 4. Widowed	A skip to 8
7	What is your pregnancy status?	1. Pregnant 2. Delivery before 6 month 3. Delivery 6 months back 4. If Other specify_____	
8	What is your educational status?	1. Illiterate 2. Read and write 3. Primary school 4. Secondary school 5. ≥High schools	
9	What is your occupation?	1. Government employee 2. Farmer 3. Merchant 4. If Other specify ____	
10	What is the estimated monthly income of your family in Ethiopian Birr?	1. <1500 Birr 2. 1501-3000 Birr 3. 3001-4500 Birr 4. 4501-6000 Birr 5. >6000 Birr	
11	How many individuals live in your house?	_____	
	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.		

12	Do you feel a Fever	A. Yes B. No	
13	Loss of energy	A. Yes B. No	
14	Is there Vomiting	A. Yes B. No	
15	Are you Sweating	A. Yes B. No	
16	Did you feel Headache	A. Yes B. No	
17	Loss of appetite	A. Yes B. No	
18	Convulsions	A. Yes B. No	
19	Chills	A. Yes B. No	
	Part three: Environmental factors		
20	Are there any mosquito breeding sites around your home?	A. Yes B No	No skip to 22
21	If yes to Q 20, which mosquito breeding sites are there?	A. Stagnant water B. Open water storage tanks. C. Domestic containers D. Constructions E. Blocked drainage F. Marshy area G. Garden H. Tires I. polluted pools J. Septic tanks K. Urban agriculture L. Unprotected dam	
22	What distance is the house from the mosquito breeding habitat?	A. < 1000 m B. 1000-2000 m C. > 2000 m D. Other (specify)_____	
23	Is there a health post in this village?	A. Yes B. No	
24	Is there a transportation service from your home to the health post?	A. Yes B. No	
25	How long does (minutes) take you on foot to arrive at the health post?	----------minutes	
26	Was ITN distributed in this village?	A. Yes B. No	
27	Is the IRS service regularly provided in this village?	A. Yes B. No	

		C. I do not know	
	Part four: Individual and household factors		
28	Do you currently have ITN at your home? (If yes, please ask him/her to show the net)	Yes B. No	No Skip to 39
29	If yes to question number 28, how many bed nets do you have currently?	In number----------	
30	Where did you get the ITN from?	A. Freely from the government B. Purchased C. Got from NGOs D. Others, specify----------	
31	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	
32	What is the reason, if 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	
33	Family member who uses ITN?	A. Whole family B. Some family member	
34	What is the condition of the net like?	A. Torn B. Dirty C. Not hanging in the appropriate position D. Others, specify_____	
35	Has this net ever been washed?	A. Yes B. No	No skip to 39

		C. Don't know	
36	If Q35 is yes, how many times has this net been washed in the last six months?	No of times_____	
37	For the last wash, what was used to wash the bed net?	A. Water and bar soap B. Water only Nowhere (managed at home) C. Other specify_____	
38	Where was the net dried?	A. Outside in the shade B. Outside in the sun C. Inside D. Other (specify)	
39	Did you know how to tack the net?	A. Yes B. No	
40	What is the type of house wall?	A. Mud plustered B. Stone walled C. Break wall	
41	Does the respondent have separate bedrooms?	A. Yes B. No	
42	If yes to question no 40, what is the total number of bedrooms?	_____ number of bedrooms	
43	Does the family have a separate kitchen?	A. Yes B. No	
44	Does your main living room have a window?	A. Yes B. No	
45	Do the windows and doors have screening?	A. Yes B. No	
46	How do you describe the surface of the walls?	A. Very smooth B. Smooth C. Rough D. Very rough with a lot of cracks	
47	Does the house have openings that allow the entry of mosquitoes?	A. Yes B. No	
48	Does the family have a toilet?	A. Yes B. No	
49	Did you travel to the malaria endemic area within the last two or three weeks?	A. Yes B. No	if no skip to Q 52
50	If yes to Q 49 did you sleep there?	A. Yes B. No	If no

			skip to 52
51	Did you use ITN there?	A. Yes B. No	
52	Previous history of malaria?	A. Yes B. No	
53	Family history of malaria?	A. Yes B. No	
54	Does the family share the house with domestic animals?	E. Yes B. No	
55	Prevalence of malaria by RDT	A. Positive B. Negative	
56	If Q 55 is positive what is *plasmodium* species?	*A. P.falciparum* *B. P. vivax* C. C mixed	
57	Prevalence of malaria by microscope	A. Hemi parasite seen B. No hemi parasite seen	
58	If Q57 is positive what is *plasmodium* species?	*A. P.falciparum* *B. P.vivax* C. mixed	

LABORATORY REQUEST

Sample code _____date_____ time_____

Malaria RDT result		Microscopic examination result		*Plasmodium* species			
Pos	Neg	Hem parasite seen	No hem-parasite seen	P. f	P.v	Mix	Remark

Name of laboratory investigator_____signature_____

_____

II. በመረጃ የተደገፈ ስምምነት

በማዕከላዊ ኢትዮጵያ ክልል ከምባታ ዞን በ ዳምቦያ ከተማ ህብረተሰብ መካከል የወባ ስፋት እና ተያያዥነት ያለው አጋላጭ ስጋቶች የጥናት ዓላማ ተነግሮኛል። በተጨማሪም በመጠይቁ ውስጥ የተካተቱት መረጃዎች በሙሉ በሚስጥር መያዝ እንዳለባቸው አሳውቆኛል። የትኛውም ድርጊቶቹ በአጠቃላይ የጤና አጠባበቅ ላይ ምንም ተጽእኖ አይኖራቸውም። ስለዚህ ሁኔታዎችን ሙሉ በሙሉ በመረዳት አስፈላጊውን መረጃ እና ናሙና ለላቦራቶሪ ትንታኔ ለመስጠት ተስማምቻለሁ። ስለ ፕሮጀክቱ ጥያቄዎችን ለመጠየቅ እድል አግኝቻለሁ እናም በምረዳው ቋንቋ እርካታዬን አግኝቻለሁ።

እኔ _____ የተጠየቀውን መረጃ እና የዚህ ጥናት ናሙና ለመስጠት በዚህ ፈቃድ ሰጥቻለሁ።

ለወላጆች/አሳዳጊዎች የስምምነት ቅጽ፡

ከላይ ያለውን መረጃ አንብቤዋለሁ ወይም ተነበበኝ። ጥያቄዎችን እንድጠይቅ እድል ተሰጥቶኝ እና ጥያቄዎቹ አጥጋቢ ምላሽ አግኝተዋል። በዚህ ጥናት ውስጥ ልጄ እንዲሳተፍ በፈቃዴ ተስማምቻለሁ። እሱ/ እሷ የደም ናሙናውን ለመሰብሰብ እና በዚህ ጥናት ውስጥ ተሳታፊ ለመሆን እና ልጄን በማንኛውም ጊዜ ከጥናቱ የማውጣት መብት እንዳለኝ ተረድቻለሁ።

ለልጆች የድጋፍ ቅጽ፡ የእንግሊዝኛ ቅጂ

ከላይ ያለውን መረጃ አንብቤዋለሁ ወይም ተነበበኝ። ጥያቄዎችን እንድጠይቅ እድል ተሰጥቶኝ እና ጥያቄዎቹ አጥጋቢ ምላሽ አግኝተዋል። በዚህ ጥናት ውስጥ እንድሳተፍ እና ወላጆቼን ወይም አሳዳጊዎቼን ፈቃዳቸውን እንዲሰጡ በፈቃደኝነት ተስማምቻለሁ። በዚህ ጥናት ውስጥ ለመሳተፍ እና የደም ናሙናዬን ለመስጠት ፈቃደኛ ነኝ እንዲሁም በማንኛውም ጊዜ ከጥናቱ የመውጣት መብት እንዳለኝ አሳውቄያለሁ።

የተሳታፊው ስም ---------- ፊርማ ---------- ቀን --- -------- ኮድ----------

የምሥክር ስም ---------- ፊርማ --- --ቀን---------አሳዳጊዎች ስም-------ፊርማ-----

የመርማሪ ስም ---------- ፊርማ ---- --- ቀን ----

Annex 7. Amharic version questionnaire

የወባ ጠቋሚ ጥናት የቤተሰብ መረጃ መሰብሰቢያ ቅጽ ቁጥር---------

1. ቀን ---/---/2015
2. ኮድ ---
3. ቀበሌ

መረጃ ሰብሳቢዉ ስም----------

	መጠይቅ ክፍሌ አንድ፡ ማህበራዊ ስነ-ሕዝብ ምክንያቶች		እለፍ
ተ.ቁ	ጥያቄ	አማራጮች	
4	እድሜህ/ሽ ስንት ነዉ?	_____	
5	ጾታ	1. ወንድ 2. ሴት	
6	የጋብቻ ሁኔታ ምን ይመስላል?	1. ያላገባ/ች 2ያገባ/ች 2. የፈታ/ች 3. ባለቤቷ/ቱ በህይወት የለም	
7	የወሊድ ሁኔታ ምን ይመስላል?	1. ነፍሰጡር 2. ከ 6 ወር በፊት የወለደች 3. ባላፈው 6 ወር ውስጥ የወለደች 4. ሌላ (ይግለጹ)	
8	የትምህርት ደረጃ	1. ያልተማረ/ች 2. መጻፍናማንበብየሚችል /ትችል 3. የመጀመሪያ ደረጃ 4. ሁለተኛ ደረጃ 5. ከሁለተኛ ደረጃ በላይ	
9	የቤተሰብ ስራ ምንድነዉ?	1. የመንግስት ሰራተኛ 2. አርሶ አደር 3. ነጋዴ 4. ሌላ (ይግለጹ)	
10	የቤተሰብ የወር ገቢ ስንት ብር ነዉ?	1. ከ1500 ብር በታች 2. ከ1501-3000 ብር 3. ከ3001-4500 ብር	

		4. ከ4501-6000 ብር 5. ከ6000 ብር በላይ	
11	የቤተሰብ ብዛት ስንት ነዉ?	_____	
	ክፍል ሁለት፡ ክሊኒካዊ መረጃ (በከፍተኛ የጤና እንክብካቤ ባለሙያዎች የሚሰበሰብ) መመሪያ እባክዎ የሚከተለውን መረጃ ለመሙላት በጥንቃቄ ግምገማ እና ቃለ መጠይቅ ያድርጉ።		
12	ትኩሳት	1. አዎ 2. የለም	
13	አቀም ማጣት	1. አዎ 2. የለም	
14	ማስመለስ	1. አዎ 2. የለም	
15	ላብ	1. አዎ 2. የለም	
16	ራስ ምታት	1. አዎ 2. የለም	
17	የምግብ ፍላጎት ማጣት	1. አዎ 2. የለም	
18	ብርድ ብርድ ማለት	1. አዎ 2. የለም	
19	መንቀጥቀ	1. አዎ 2. የለም	
	ክፍል III የአካባቢ ሁኔታዎች		
20	በአካባቢያችሁ ለወባ ትንኝ መራቢያ የሚሆን የቆመ ውሃ አለ?	2. አዎ 3. የለም	የለም ወደ ቁጥር-22 ይለፉ
21	1. መሌስዎአዎ ከሆነ ምን አይነት የወባ ትንኝ መራቢያ ቦታዎች አለ?	1. የቆመ ውሃ 2. ክፍት የውኃ ማጠራቀሚያ ታንኮች 3. የቤት ውስጥ ማጠራቀሚያ 4. የግንባታዎች አካባቢ 5. የታገደ የፍሳሽ ማስወገጃ 6. ረግረጋማ አካባቢ 7. የአትክልት ቦታ 8. ጎማዎች 9. የተበከላ ገንዳዎች፣ 10. የቆሻሻ ማጠራቀሚያ ታንኮች 11. የከተማ ግብርና	

		12.ያልተጠበቁ ግድቦች	
22	ቦታው ከቤትዎ በምን ያህል ይርቃል ?	1. <1km 2. > 2km	
23	በዚህ መንደር ውስጥ የጤና ተቋም አለ ?	1. አዎ 2. የለም	
24	ከቤትዎ ወደ ጤና ተቋም የመጓጓዣ አለ?	1. አዎ 2. የለም	
25	ወደ ጤና ጣቢያ ለመድረስ (ደቂቃዎች) በእግርዎ ምን ያህል ጊዜ ይወስዳል?	-----ደቂቃዎች	
26	ITN በዚህ መንደር ተሰራጭቷል?	1. አዎ 2.የለም	
27	በዚህ መንደር የIRS አገልግሎት በመደበኛነት ይሰጣል?	1. አዎ 2. የለም	
	ክፍል II፡ የቤተሰብ እና የግለሰብ ሁኔታዎች		
28	በቤትዎ ውስጥ አጎበር አለ?	1. አዎ 2. የለም..	የለም ቁጥር-39ይለፉ
29	መልስዎ አዎ ከሆነ ምን ያህል አጎበር አልዎት?	1. አንድ 2. ሁለት 3. ሶስት 4. ከሶስት በላይ	
30	አጎበር ከየት አመጣቸው	1. ከመንግስት ነፃ 2. የተገዛ 3. ከNGO የተገኘ 4. ሌሎች---	
31	አጎበር የት አለ?	1. ቤሚተኛበት ተንጠልጥሎል። 2. ተጣጥፎ ታስሮ ተቀምጧል 3. አልተሰቀለም፣ ግን አልተቀመጠም 4. አልተሰቀለም ተከማችቷል። 5. በጥቅሉ ውስጥ ተከማችቷል።	
32	አጎበር ካልዎ የማይጠቀሙበትን ምክንያት ይግለጹ?	አጎበርን ለመስቀል አስቸጋሪ ነው አጎበር በጣም አጭር ነው አጎበርን ለመስቀል ምንም ቦታ የለም። አጎበርን የሚሰቅለው የለም።	
33	አጎበር የሚጠቀሙ የቤተሰብ አባል?	1. መላው ቤተሰብ 2. አንዳንድ የቤተሰብ አባላት	
34	የትንኝ መከላከያ አጎበር ሁኔታ ?	1. ንጹህ ጥሩ ነው (ቀዳዳ የለውም) 2. ቆሻሻ 3. በተገቢው ቦታ ላይ አለመንጠለጠል	

35	ይህ አጎበር ታጥቦ ያውቃል?	1. አዎ 2. የለም..	የለም ከሆን ወደ ቁጥር-39 ይለፉ
36	Q35 አዎ ከሆነ፣ ባለፉት ስድስት ወራት ውስጥ ይህ አጎበር ስንት ጊዜ ታጥቧል?	----------	
37	ለመጨረሻው መታጠቢያ, የአልጋውን መረብ ለማጠብ ምን ጥቅም ላይ ይውላል?	1. የውሃ እና የባር ሾርባ 2. ውሃ ብቻ 3. ሌሎች ይግለጹ _____	
38	አጎበር የት ደረቀ?	1. በጥላ ውስጥ ውጭ 2. በፀሐይ ውጭ 3. ውስጥ 4. ሌላ (ይግለጹ)	
39	አጎበርን እንዴት እንደሚሰቀል ያውቃሉ?	1. አዎ 2. የለም	
40	የቤቱ ግድግዳ ምን ዓይነት ነው?	ጭቃ ተለጥፏል የድንጋይ ግድግዳ በግድግዳ የተዘጋ	
41	የተለየ መኝታ ቤት አለ?	1. አዎ 2. የለም	
42	ጥያቄ ቁጥር 41 ከሆነ፣ አጠቃላይ የመኝታ ክፍሎች ብዛት ስንት ነው?	የመኝታ ክፍሎች ብዛት----	
43	ቤተሰቡ የተለየ ወጥ ቤት አለው?	1. አዎ 2. የለም	
44	ዋናው የሳሎን ክፍልዎ መስኮት አለው?	1. አዎ 2. የለም	
45	መስኮቶቹ እና በሮች ማጣሪያ አላቸው?	1. አዎ 2. የለም	
46	የግድግዳውን ገጽታ እንዴት ይገልጹታል?	1. በጣም ለስላሳ 2. ለስላሳ 3. ሻካራ 4. በጣም ሻካራ ከብዙ ስንጥቆች ጋር	
47	በቤቱ ግድግዳ ላይ ቀዳዳ አለ?	1. አዎ 2. የለም	
48	ቤተሰቡ ሽንት ቤት አለው?	1. አዎ 2. የለም	
49	ባለፉት ሁለት ወይም ሶስት ሳምንታት ውስጥ ወባ ወደሚገኝበት አካባቢ ተጉዘዋል?	1. አዎ 2 የለም	የለም ከሆን ወደ ቁጥር-52ይለፉ

50	ለ Q 49 አዎ ከሆነ እዚያ ተኝተሃል?	1. አዎ 2. የለም	የለም ቁጥር-52 ይለፉ
51	እዚያ ITN ተጠቅመዋል?	1. አዎ 2. የለም	
52	ከዚህ በፊት የወባ ታሪክ አለ?	1. አዎ 2. የለም	
53	የወባ ቤተሰብ ታሪክ አለ?	1. አዎ 2. የለም	
54	ቤተሰቡ ቤቱን ከቤት እንስሳት ጋር ይጋራል?	1. አዎ 2. የለም	
55	Prevalence of malaria by RDT result	1. Positive 2.Negative	
56	If Q 55 is positive what is *plasmodium* species?	1. *P.falciparum* 2.*P.vivix* 3. mixed	
57	Prevalence of malaria by microscope	C. Hemi parasite seen D. No hemi parasite seen	
58	If Q57 is positive what is *plasmodium* species?	*D. P.falciparum* *E. P.vivix* F. mixed	

II. Consent or assent form in Kambatissa

Simiminati formaa anaakaa/leisaarii:

Aluudiin yoo naqasha anababamee'e te anini anababeem. Xammuta xami saamu asameene xameemi xamo asantoo fanqashut bajigsee'e. Kan sereegaan tasaatafotane faqaadagna ihan hasisano qegi naamuna aasota faqaadagna ihue ccaakisaaam.

Assent form for children: English version: Aluudiin yoo naqasha anababeemi te anababamee'e .Xammuta xamunta saamu aasameene xameemi xamooha aasamoe fanqashoon wozanui usheexiyeeu. Ciilui te ciilai kan sereegan tasaatafunta faqajeem.Kaneenin bargi ciilui te ciilai kan sereegaan tasaatafii faqadagnakata qeg naamunahaa aasitota iitamusa caakiseeu.

Tasaataafe su'mmu _____Firmu_____ Barru_____

Ciilis su'mmu (coodu)____leisaan su'mmu----------firmu ___ barru_____

Misikir su'mmu_____ firmu_____barru_____

Maramaraanch su'mmu_____firmu_____ barru_____

Annex 8. Xa'mmatuta hegeegis afeen

1. Barru:_____/_____/2015 MW
2. Coodi woollut:_____/_____
3. Kabalit: _____

Naqaasha quma'saanch su'mmu _____firmu_____

	Kifill matu: Serregaanitas yoo manna ccaakisaa xawaakat		
Kodda wollut	Xa'mmut	Dooratuti	Higg
4	Meeguki mahaan?	1. Goochoo 2. Meseleeta	
5	Ummuruk meootti?	----------	
6	Mini atteetido?	1. Aagisuba 2. Aagisheem 3. Anana ikeem 4. Machuse reheeiit	
7	Hoonge hagaru?	1. Hoongata 2. Hoongataba'a	
8	Rosha hagaru?	1. Tamaarubu/ta 2. Anababuhaa xafuhaa danadano 3. Wona gardaba 4. Lank gardaba 5. Colleejahaa digrita	
9	Hujik mahaan?	1. Mangiste ashikarchu 2. Bare maqee hujita hujataach 3. Zazalaancho 4. Magistibii ihubo dirjitan hujatano 5. Minita Manchu 6. woloot	
10	Agani aagut tophe birriin meoot?	1. 1500 Birriich woroodo 2. 1501-3000 Birra 3. 3001-4500 Birra 4. 4501-6000 Birra 5. 6000 Birriich aluudo	
11	Min man batinit meoot?	_____wolloon	
	Kifil lamu: "Clinical" naqaasha (Fayima lubaamaan wiimano) Azazuta: Danaamoga xammiteen woroodiin yoo naqasha wiinshiye.		
12	Iibu	A. Aa B. Aaba'a	
13	Maqoo hoogu	A. Aa B. Aaba'a	
14	Goxansu	A. Aa B. Aaba'a	

15	Hunkeesu	A. Aa B. Aaba'a	
16	Damuumit	A. Aa B. Aaba'a	
17	Icha hasanat kotu	A. Aa B. Aaba'a	
18	Huxisu	A. Aa B. Aaba'a	
19	Gidu	A. Aa B. Aaba'a	
	Kifil sasu: Hegeegi xawaakat		
20	Hegeegoontane gedamee wou yooido?	A. Aa B. Aaba'a	No skip to 22
21	Xammo 20 aa ikoda ,hakkan manaaka yoii?	A. Egedamo wou B. Fanatee woi odaat C. Ginbaat hujjit D. Xufamee woi driisaanchu E. Muxxu hegeegu F. Kolbame eelu G. Taankeer H. Katam hoggut I. Constructionnu J. Qorabamubu eelu K. Wollu yooda kul----------	
22	Wo yoo maneech min iilanqaxeee yoo qeerimat hawanka?	A. 1000 meetriich worodoo B. 2000 meetriich aluudoo	
23	Xeena kellu yooido kan hegeegoon?	A. Aa B. Aaba'a	
24	Kaameeli kaalatut yooido?	A. Aa B. Aaba'a	
25	Xeena kella iilanqaxee lokaan hawanka dakiika xamano?	----------dakiika	
26	Kan hegeegoon agoobaru behameido?	A. Aa B. Aaba'a	
27	Shekeere biibita shano keemiikalu kan hegeegoon kiifameeido?	A. Aa B. Aaba'a	
	Kifil shoolu: Gilasabina mini gashaani xawaakat		
28	Tan jaan mineetak agoobaru yooido?	A. Aa B. Aaba'a	Aaba'a 39 hig
29	Xammo 28 aa ikoda,meu agoobaru yoou?	Wolloon----------	
30	Agoobaras hanooch daqiteen?	E. Gash wudiin xalaPurchased F. Mangstibii ihubo drijitiich G. Hirineet	

31	Agoobarus hakaneneet yooii?	A. Osaeenobaan bidiqik saqalamee B. Qumuchik xaaxam saqalameeu C. Saqalamiba xawuikodaaafuuliba D. Hiiram kei afuuliyeeu E. Hiiramunan afuuliyeeu	
32	Osaeenobaan saqalamuboda gajaajus mahaan?	A. Agoobarasu salii keemasha B. Agoobarus gabachoo C. Mnnit yooba D. Saqalano mannu yooba	
33	Min maniich ayeet agoobar aazeen osa'anoohu?	A. Horrumku B. Horaaba'a	
34	Agoobarsi duhat ma agudaau?	A. MuccurO B. Xureeu C. Xabeenagiin saqalamiba'a D. Wollu yooda kul	
35	Aansham kasado?	A. Aa B. Aaba'a	Aaba'a 39 tiba higg
36	Xamo 35 aa ikoda meita kodata aansham kasa?	Meita kodata_____	
37	Maccaraash koda aanshoon ma tamitteent?	A. Woahaa samunahaa B. Woa xalle C. Wollu yooda_____	
38	Agoobarus hakaneneet moolanahu?	A. Hada haleechoon B. Hada ariichoon C. Mini aazeen D. Wollu yooda kul	
39	Agoobara erit daganido?	A. Aa B. Aaba'a	
40	Min girgidu miicheet hujatamoo?	A. Orcciin xaalalameeha B. Girgidus kiniin minameehaa C. Girgidus beehameeha	
41	Ananu kifilu yooido?	A. Aa B. Aaba'a	
42	Xammo 40 aa ikoda horooman meu kifilu yoou?	_____ wolloon	
43	Ichata sholeeno ananu kifilu yooido?	A. Aa B. Aaba'a	

44	Qome galite miniiha maskootu yoosido?	A. Aa B. Aaba'a	
45	Maskootiihaa goocciihaa teelaanchu yooido?	A. Aa B. Aaba'a	
46	Girgdid ali hatiguta ccaakisan?	A. Abish liilaasha B. Liilaasha C. Shakaara D. Abish shakaara	
47	Shekeere biibita aagisno xalaalu yooido?	A. Aa B. Aaba'a	
48	Shuma minu yooido?	A. Aa B. Aaba'a	
49	Higo lamo te saso hezeet aazen shekeerit yoo hegeegu marteentido?	A. Aa B. Aaba'a	Aaba'a 52tiba hig
50	Xamo 49 aa ikoda hikan martoontibaan galteentidoe?	A. Aa B. Aaba'a	Aaba'a 52tiba hig
51	Galtoontibaan Agoobara tamiteentido?	A. Aa B. Aaba'a	
52	Kaniich bire xidant kasando?	A. Aa B. Aaba'a	
53	Min maniich kaniich bire xidamikasado?	A. Aa B. Aaba'a	
54	Mini aaz ameezanatii manuhuu galanoohu mexoomaneetido?	A. Aa B. Aaba'a	
55	Shekeere RDT wuxeetu	A. Positiva B. Negativa	
56	Xamo 55 aa ikoda *plasmodeemis* sheefit mahaan?	*A. P.falciparum* *B. P.vivix* C. Lamoonka	
57	Microscope mirmaar wuxeetu	A. Qeg aazi parasaytu you B. Qeg aazi parasaytu yoba'a	
58	Xamo 57 aa ikoda *plasmoodeemis sheefit mahaan?*	*B. P.falciparum* *C. P.vivix* D. Lamoonka	