Original Articles
Prevalence and associated risk factors of malaria among under-five years children in Ilugalan district, Oromia Region, Western Ethiopia

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Abstract

Background: *Under-five children are at high risk of malaria-associated morbidity and mortality, however studies on community-based malaria in under-five children in Ethiopia are limited. Hence this study was conducted to investigate prevalence and associated risk factors among under-five children in the Ilu Galan district.*

Methods: *A community-based cross-sectional study was conducted from April to June 2023. Among five Kebeles selected by random sampling, 557 under-five children were chosen using systematic sampling. Malaria presence was assessed by microscopic examination and rapid diagnostic tests. Data on sociodemographic and risk factors were collected using a structured questionnaire. Bivariate and multivariable logistic regression identified predictors with adjusted odds ratios, 95% confidence intervals, and P < 0.05 as statistically significant.*

Results: *The prevalence of malaria among under-five children was 5.2% (95% CI = 3.5-7.4). The majority (71.4%) were infected with P. falciparum, followed by P. vivax (25%), and mixed infection (3.6%). Staying outdoors at night (AOR=3.09; 95% CI=1.01-9.48), ITN utilization (AOR=0.26; 95% CI=0.07-0.94), presence of eaves (AOR=4.08; 95% CI=1.20-13.44), less than 1 km distance from the river (AOR=4.32; 95% CI=1.19-15.62), and stagnant water nearby (AOR=11.40; 95% CI=3.71-35.02) increased malaria odds.*

Conclusion: *This study found a 5.2% malaria prevalence among under-five children, mainly caused by Plasmodium falciparum. Key risks included outdoor exposure, proximity to rivers, stagnant water, and poor housing. Promoting ITN use and addressing environmental risks are essential for pre-*

Keywords: *Malaria infection, Prevalence, Children, Ilu Galan, West-Ethiopia*

Introduction

Malaria is vector born life treating disease caused by Plasmodium species. In 2022 alone globally 249 million cases and 608, 000 deaths were reported (1). Most (94%) of the malaria cases and (95%) deaths were from WHO African countries, where under-five children account for 80% of malaria deaths (2).

Malaria remains a leading public health problem in Ethiopia, where 75% of the area was malarious and 68%-70% of the people lives in the risk areas (3). The burden of malaria in the country increase from 1.1 million in 2021 to 1.5 million in 2022 (4). Majority (60%) of cases were due to Plasmodium falciparum and Plasmodium vivax account for (40%). Malaria cases reached peak after heavy rain season from September to December, which drop during the light rainy season April to May (3). Anopheles arabiensis are primary vectors for the transmission and Anopheles pharoenesis, Anopheles funestus, and Anopheles nili are also involved (5). Under-five children are among the highly venerable ones, where the magnitude of malaria infection in this age group ranges from 16 to 54% in the country (6). In Oromia region malaria is among the five top diseases that has significant public health importance, where in 2022 alone 727,738 cases were reported (7). The prevalence of malaria in the region vary from place to place and among symptomatic children (10.48%) (7) and asymptomatic (10.46%) (8).

Despite the favorable weather conditions and the records in the Ilu Galan district health office indicating that malaria cases of under-five children were registered at both outpatient and inpatient clinics particularly in under five children there is no scientific report with regards to malaria prevalence and associated risk factors among under-five children. Hence, this study aimed to fill the gap by determining the prevalence of malaria and finding potential risk factors associated with malaria in under five-year children in Ilu Galan district.

Material and methods

Study area

Ilu Galan district is located in the West Shewa Zone and 215km away from Addis Ababa. It is located between 8°56′30″N and 8°59′30″N latitude and 37°47′30″E and 37°55′15″E longitude. The altitude of the district was between 1600 to 1900m above sea level with average rain fall of 1000 to 1200 mm3 and mean temperature of 18.87°C. Transmission of malaria in the district was unstable and seasonal and 18 kebeles were malaria endemic. The main economic activities in the area are livestock breeding and subsistence farming. There are 7218 households who have 9760 under-five aged children. In the district, there are three health centers, and eighteen health posts. All health facilities give diagnostic and treatment services to the community.
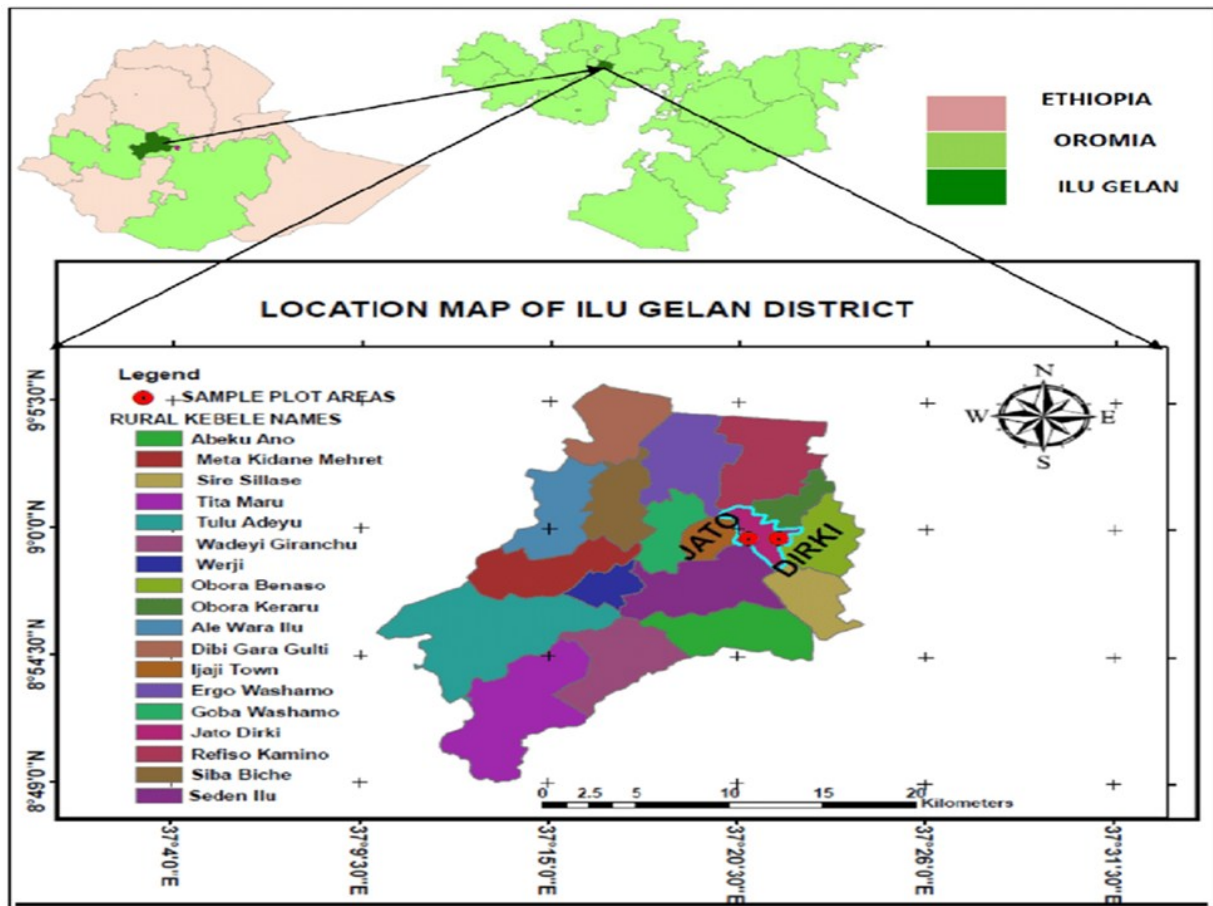
Fig. 1: Map showing the location of the study area.

Study design

Community-based cross-sectional study was conducted from April to June 2023. Five kebeles (Ejaji Town, Ale Wara Ilu, Siba Biche, Jato and Goba Washabo) were selected randomly from 18 kebeles. A multi-stage sampling approach were applied to select the study participants. Households with at least one under-five child were selected from selected kebeles using a systematic random sampling technique. Households with under-five children were obtained from the Kebeles' community health information system at health posts. The sampling interval (K was obtained by dividing the number of households by the sample size.

Sample size determination

Single population proportion formula ($n = Z2\ P\ (1-P)/d2$), was used to calculate the sample size by considering proportion of 50 % and 5% of margin of error. Assuming a 10% non-response rate, applying 1.5 design effect, at 95% of confidence level the final sample size was 557. Five kebeles (Jaji Town, Ale wara ilu, Siba biche,jato and Goba Washabo) were selected by lottery method from the total of 18 kebeles in the district. The total number of households in each selected kebeles who have under-five children was obtained from the community health information system (CHIS) of the health post. Households with at least one under-five year children were

selected from selected kebeles using systematic random sampling techniques after proportional to size allocation based on the number of households in each kebele. Hence, proportionally from Ejaji (175), Ale Wara Ilu (159), Sibabiche (116) Jato (55), and Goba Washabo (52) and finally simple random sampling technique was implemented to select 557 under five children (Fig 2)
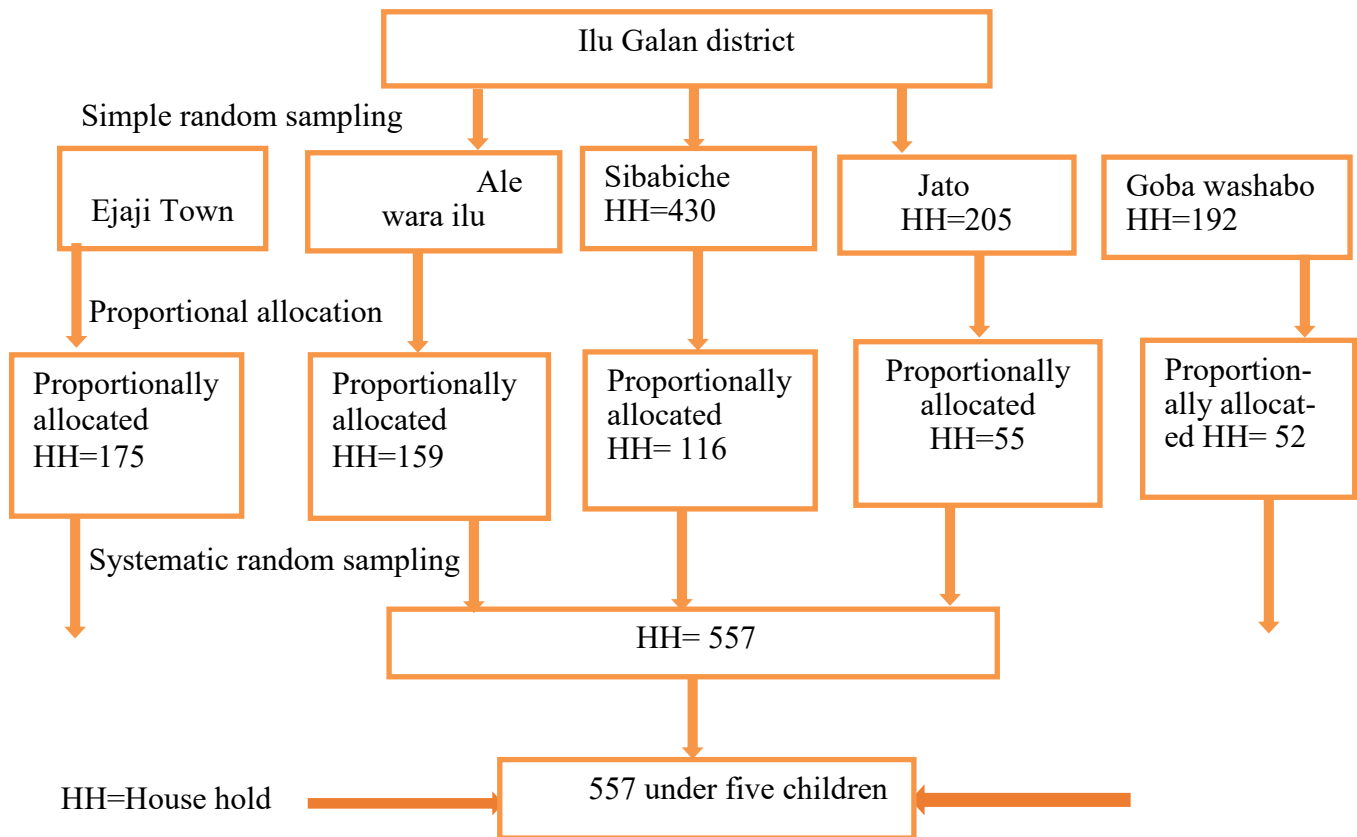

Fig. 2: Schematic diagram of the study sampling technique

Data collection procedures

Data of sociodemographic and malaria associated risk factors were collected using pre-tasted structured questionnaire that was translated to local language ''Afaan Oromo''. Blood was drawn from children finger using sterile lancet on frosted slides and thick and thin smears were prepared and air dried. Thin films were fixed with methanol, and thin and thick films were stained with 10% Giemsa stain for 15 minutes and washed with distilled water and air dried. Thick smears were used to detect Plasmodium infection, while thin smears to identify species by oil immersion objective. StartTM Malaria RDT kit was used to detect histidine-rich protein 2 (HRP2) of Plasmodium falciparum and plasmodium lactate dehydrogenase (pLDH) of Plasmodium vivax.

Data quality assurance and Quality Control

Before data collection, a structured questionnaire was developed in English and translated into Afaan Oromo (local language). Two days of training were given to data collectors by the investigators. A pretest was conducted on 5% of the sample size by involving participants from nearby Kebles with similar socio-demographic and environmental conditions. All laboratory procedures were conducted based on standard operating procedures. Clean, labeled, and grease-free frosted end slides were used for blood film preparation to avoid scratches on the slides. All Care Start TM malaria test kits were labeled and the test was done according to the manufacturer's instructions. A slide was considered negative after two laboratory technologists examined 200 fields without finding a Plasmodium parasite. Further discordant slides between the microscopic readings and RDT and microscopy were investigated for the third time by a senior laboratory technologist at Ambo University Referral Hospital.

Data processing and analysis

Data were entered and analyzed using SPSS version 26. Descriptive statistics was used to assess the prevalence and determinant factors and results were revealed by tables and figures. Bivariate and multivariable logistic regression models were used to evaluate association between dependent and independent variable. Adjusted odds ratios (AOR) with a 95% confidence interval (CI) were used to determine the strength of the association. P-value <0.05 was considered statistically significant.

Results

Socio-demographic characteristics of study subjects

Among 557 selected under-five children, 542 were involved in the study with response rate of 97.3%. Of these children, the majority (57.6 %) were male. The majority (68.5%) of the children were from rural areas the rest were from urban. The age range of the under-five children was between 2 and 59 months with a mean age of 27 months (SD=16.18). The majority (26.4%) were in the age group of <12 months (26.4 %) (Table 1).

Table 1: Socio-demographic characteristics of under-five children in Ilu Galan district, Oromia Regional State, West Ethiopia, 2023.

Socio-demographic characteristics	Category	N (%)
Sex	Female	229 (42.3)
	Male	313 (57.6)
Age (Months)	<12	143(26.4)
	12-23	105(19.4)
	24-35	108(19.9)
	36-47	85(15.7)
	48-59	101(18.6)
Residence	Urban	171(31.5)
	Rural	371(68.5)
Family size	<5	312(57.6)
	≤5	230(42.4)
Educational status of care givers	No formal education	114(21)
	Read and write only	153(28.2)
	Primary school	236(43.5)
	Secondary and above	39(7.2)
Occupation of care givers	Hose wife	79(14.6)
	Farmer	398(73.4)
	Daily laborer	26(4.8)
	Sivil servant	14(2.6)
	Business man	25(4.6)

Prevalence and density of malaria

The overall prevalence of malaria among under-five children in Ilu-Galan district was 5.2% (95% CI = 3.5-7.4). Of this majority (3.7%) of the infection was due to P. falciparum followed by P. vivax (1.3%) and mixed infection (0.2%). Of the total 28 microscopically confirmed malaria species (85.7%) were also detected by the rapid diagnostic tests (RDTs) (Table 2). Majority (53.6%) of them were males and (46.4%) were females. There was no statistically significant variation in malaria prevalence among sexes (P = 0.83). The highest (15.8%) prevalence of malaria was identified among the age group of 48-59 followed by age group of 36-47 months (5.9%) (Table 3). The dominant species with regards to species distribution is P .falciparum (71.4%) followed by P. vivax (25%) and mixed infection (3.6%).

Table 2: Socio-demographic variables and malaria infection among children under-five years in Ilu Galan district, Oromia Regional State, West Ethiopia, 2023.

Variable	Catego-ries	N	Positive N (%)	P. falciparum N (%)	P.vivax N (%)	Mixed N (%)	Negative N (%)
Sex	Female	229	13 (5.7)	11 (84.6)	1 (7.7)	1 (7.7)	216 (94.3)
	Male	313	15 (4.8)	9 (60)	6 (40)	0 (0)	298 (95.2)
Age in months	<12	143	3 (2.1)	2 (66.7)	1 (33.3)	0 (0)	140 (97.9)
	12-23	105	0 (0)	0 (0)	0 (0)	0 (0)	102 (100)
	24-35	108	4 (3.7)	4 (100)	0 (0)	0 (0)	104 (96.3)
	36-47	85	5 (5.9)	4 (80)	1 (20)	0 (0)	80 (94.1)
	48-59	101	16 (15.8)	10 (62.5)	5 (31.3)	1 (6.2)	85 (84.2)
Residence	Urban	171	7 (4.1)	3 (42.9)	3 (42.9)	1 (14.3)	164 (95.9)
	Rural	371	21 (5.7)	17 (81.0)	4 (19.0)	0 (0)	350 (94.3)
Total		542	28 (5.2)	20 (3.7)	7 (1.3)	1 (0.2)	514 (94.8)

Regarding density of parasitemia with respect to age and sex (53.6%) of the under-five children had less than 1000 parasites/□L of which majority (69.2%) were female. The highest parasitemia level (1000-9999 parasites/µL of blood) was observed in the age group 24-35 months and the lowest was observed in age group <12months years old.

Table 3: Levels of parasite density by sex and age group among the parasitemic under five children, in Ilu Galan district, Oromia Regional State, West Ethiopia, 2023.

Variable	Categories	Low (<1000) N	(%)	High (1000-9999) N	(%)	Total
Sex	Female	9	(69.2)	4	(30.8)	13
	Male	6	(40)	9	(60)	15
Age in months	<12	2	(66.7)	1	(33.3)	3
	12-23	0		0		0
	24-35	1	(25)	3	(75)	4
	36-47	3	(60)	2	(40)	5
	48-59	9	(56.2)	7	(43.8)	16
Total		15	(53.6)	13	(46.4)	28

Factors associated with malaria infection

Potential malaria-associated factors that showed a P-value < 0.25 in the bivariate analysis were entered for multivariate analysis. Six variables (Staying out door during night, using Insecticide Treated Net (ITN), exposure to Indore Residual Spray(IRS) service, Presence of eave, Household distance from the river, and Presence of stagnant water) were significantly associated with malaria infection (P <0.05). As the adjusted model indicated under five-year children who stay outdoor at night were 3.1 times more likely to be infected with malaria (AOR = 3.1, 95% CI = 1.01–14.68) than those who did not. Children living in houses that were sprayed with IRS service in the last

12 months were 11.8 times more likely to be protected (AOR = 11.8, 95% CI = 2.20–63.65) than those who did not. Households greater than 1 kilometer away from the river were 4.3 times more likely to be protected AOR = 4.3, 95% CI = 1.20–15.63) than those less than 1 kilometer. Presence of stagnant water near the house would expose children 11.4 times more likely than (AOR = 11.4, 95% CI = 3.74–34.02) than those far away. Houses with eaves were 4 times more likely to expose under- five children to malaria infection than those without eaves. Children living in houses with impregnated bed nets (ITN) were more protected than those in houses without ITN (Table 5).

Table 5 Multivariable logistic regression analysis of associated factors for malaria, in Ilu Galan district, Oromia regional state, Western Ethiopia, 2023.

Variables	Category	Malaria		COR(95% CI)	AOR (95% CI)
		Yes	No		
		N (%)	N (%)		
Family size	≥5	19 (8.3)	211 (91.7)	3.03(1.35-6.83)	2.81(.89-8.83)
	<5	9 (2.9)	303 (97.1)	1	1
Staying outdoor during night	Yes	17 (17.3)	81 (82.7)	8.26(3.73-18.28)	3.09(1.01-9.48)
	No	11 (2.5)	433 (97.5)	1	1
Presence of ITN	Yes	7 (2.1)	332 (97.9)	0.18(0.08-.434)	0.26 (0.07-.94)
	No	21 (10.3)	182 (89.7)	1	1
IRS service in the last 12 months	Yes	4 (11.8)	30 (88.25)	2.69(0.87-8.25)	11.83(2.20-63.65)
	No	24 (4.8)	484 (95.3)	1	1
Presence of eave	Yes	21 (9.8)	193 (90.2)	4.99(2.08-11.96)	4.08(1.20-13.45)
	No	7 (2.1)	321 (97.9)	1	1
Information about malaria	Yes	11 (2.5)	424 (97.5)	0.14(0.06-.30)	0.29(0.08-1.10)
	No	17 (15.9)	90 (84.1)	1	1
Household distance from the river	<1km	22 (14.0)	135 (86.0)	10.29(4.09-25.93)	4.32(1.19-15.62)
	≥1km	6 (1.6)	37 (98.4)	1	1
Cleaning stagnant water in broken containers	Yes	12 (2.4)	484 (97.6)	0.05(.020-.11)	0.34(.087-1.32)
	No	16 (34.8)	30 (62.5)	1	1
Presence of stagnant water	Yes	18 (27.7)	47 (65.2)	17.89(7.81-40.98)	11.39(3.71-35.02)
	No	10 (2.1)	467 (97.9)	1	1
Unprotected dam for irrigation	Yes	10 (7.8)	118 (92.2)	1.86 (.85-4.15)	0.63(.18-2.22)
	No	18 (4.3)	396 (95.7)	1	1

Discussion

We conducted a cross-sectional investigation to assess the prevalence of malaria infection and associated risk factors among under-five children in Ilu Galan district. In this investigation the overall prevalence of malaria was 5.2%, which is lower than the studies done in different parts of Ethiopia, Tselemt district north Ethiopia (20.5%) (9), Jima town (11%) (10), and Benishangul 15.9% (11) and in African countries such as Uganda (19.04%) (12), Malawi (33%) (13), Ghana (20.9%) (14). However, the prevalence was higher than that of the study done in Sherkole refugee camp, Ethiopia (3.9%) (15). The discrepancy could be a result of the different geographical variations and malaria prevention and control initiatives carried out in the studied locations.

Among malaria-positive cases P. falciparum was the dominant species (3.7%), followed by P. vivax (1.3%) and mixed infections (0.2%) in this study. Similar findings were documented in study conducted in Sanja Town, Northwest Ethiopia, where the prevalence of P.falciparum and P.vivax was 5.2% and 1.6% respectively (16). But lower than that of a study done in Damote Gale district, Southern Ethiopia where the prevalence of P.falciparum and P.vivax and mixed infection was 44.1%, 42.1%, and 13.2% respectively (17). This discrepancy may be because of the fact that the study area's relatively lowland climatic conditions, where P. falciparum is a common species in the lowlands, as well as the possibility of treatment failure or recrudescence for P. falciparum, cannot be ruled out.

The prevalence of malaria was greater in age groups between 48 -59months (15.8%) than in other age groups, which is inconsistent with studies conducted in Tanzania that indicate a prevalence of (14.8%) [18] and in Malawi (13.7%) (13). But lower than the study in Arba Minch "Zuria" district that indicated a prevalence of (27.9%) (19). In this study it was observed that malaria cases increased with age and were lowest in infants under one year old. Our finding goes with a study in Ghana (14). This might be because maternal antimalarial antibodies transferred to the fetus in the last trimester of pregnancy protect the infant from early infections before they wane (20). Malaria prevalence was found to be greater in rural (5.7%) as compared to urban dwellers (4.1%). Similar findings were documented in Kenya (21) and Uganda (22). This may be due to favorable condition for vector proliferation, lower housing quality, and poor drainage systems (23).

The majority (53.6%) of infected children had a low parasite density (<1000 Parasites / μL blood). The finding was in line with the study in Sanja Town, Northwest Ethiopia (16). But lower than a high parasite density found in East Central Tanzania 69.4% (18). The immunological conditions, age category, and dietary status of the study participants could have an impact on parasite density (24).

Children who stayed outdoors at night were 3.09 times more likely to be exposed from malaria infection than those that did not. It was in line with the previous studies in other places in Ethiopia Armachiho (25), Dembia district (26) and Sherkole (15), and in Zimbabwe (26). This could be explained by exophagic-exophilic mosquito biting behavior (27). As compared to those children who don't utilize ITN, children that utilize ITN had a reduced risk of malaria infection. The finding is in agreement with earlier studies in East Shewa zone of Oromia regional state (15), Southern Ethiopia (28), West Ethiopia Sherkole (15), and Nigeria (29).

Children who live in houses with eaves were 4.08 times more likely to have a higher risk of acquiring malaria infection than those in the houses without eave. This is supported by the

studies conducted in some localities in Ethiopia (30). The presence of eave(s) might enable mosquitoes to enter inside houses, and this increases the probability of indoor mosquito bites. The presence of a river close to a house (<1 km) has shown a significant association. Children who lived in proximity to a river (<1km) were 4.3 times more likely to have a risk of getting malaria infection than those who lived far from the river(≥1km). This is supported by the study in Southwestern Nigeria (31). Studies also witness that the relationship between malaria vector density and the distance of settlement from a water body like a river is an important indicator of malaria transmission (10).

Stagnant water around the home was significantly associated with malaria transmission and increased the odds of malaria transmission among children by approximately eleven times compared with those without stagnant water around their homes. The finding is in line with supported by the study conducted in Southwestern Ethiopia (28) and Northwest Ethiopia (26). Previous studies have demonstrated that stagnant water is a favorable breeding site for mosquito development and proliferation, leading to increased malaria transmission (32).

Conclusion

The prevalence of malaria in under-five children in Ilu Galan district was 5.2%. Outdoor stay at night, presence of eave on the house, IRS service in the last 12 months, less than 1km distance of household from river, and presence of stagnant water nearby house were the predictors of risk of malaria. While utilization of ITN and health information are protective. Hence, the concerned bodies at the local or national level and expertise should focus on affording health education and information to the community on the efficient utilization of ITN, abolishing stagnant water, and not to stay outdoors at night.

Declarations

Acknowledgments

Ethical considerations

Ethical clearance was obtained from the institutional reviewed board of the College of Medicine and Health Science, Hawassa University (Ref. No. IRB/200/2015). Permission was obtained from the West Shewa Zone Health Director, Ilu Galan District Health Office, and the Chairman of kebele administrations. The parents/caregivers were given detailed explanations about the study's objectives, procedures, and potential risks and benefits, and gave written consent consequently.

Confidentiality was maintained by using codes instead of names for all participant-related data. All positive cases were linked to the nearest health institution for appropriate treatment as per the national treatment guideline.

Authors' contributions

LF drafted the proposal and SA and MH reviewed it. LF collected the required data and analyzed it. All the authors participated in the write-up of the paper. All authors read and approved the final manuscript.

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Availability of data and materials:

The datasets supporting the conclusions of this article are included within the article.

Competing interests:

The authors declare that they have no competing interests.

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