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Determinants of malaria infection among under five children in Gursum district of Somali region, Eastern Ethiopia

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Abstract

Background Despite significant efforts to control malaria infections in recent years, new infection rates continue to pose a major public health challenge in sub-Saharan Africa, including Ethiopia. This study aims to identify the key factors of malaria infection among children under five years (U5) in the Gursum district of Somali region, Eastern Ethiopia.

Methods An institution-based case–control study was conducted over two months, from June to July 2020. The study included 247 participants, divided into 82 cases and 165 controls, with a case-to-control ratio of 1:2. It focused on households with children under the age of five who received care at three health centers within the district. The investigation involved identifying *Plasmodium* species using rapid diagnostic tests and microscopic blood film examination. A logistic regression model was employed to analyze the factors affecting the outcome, using statistical software STATA-13/15. Odds ratios and the corresponding confidence intervals were calculated to identify potential predictors in the logistic regression model.

Results A multivariate analysis identified five exposures significantly associated with malaria positivity among children: living near a source of water [adjusted odds ratio (AOR) = 3.60 (1.73–7.48)], residing in rural areas [AOR = 3.58 (1.56–8.21)], living in houses with openings or holes in the walls that facilitate mosquito entry [AOR = 5.00 (2.22–11.28)], and not receiving malaria health information [AOR = 2.12 (1.06–4.21)]. Additionally, proximity to malaria vector breeding habitats [AOR = 4.74 (2.27–9.90)] was significant for malaria positivity. These five factors emerged as the primary determinants of malaria positivity among U5 children in the Gursum district.

Conclusion The study indicates that critical factors contributing to malaria positivity among U5 children in the Gursum district are related to a lack of awareness, housing conditions, and proximity to vector breeding sites. Therefore, social mobilization and targeted malaria interventions at the community level are essential for reducing disease transmission, particularly among the most vulnerable children.

Keywords Children, Ethiopia, Malaria, Mosquito, Risk factors

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Background

According to the latest report from the World Health Organization (WHO) on global malaria estimation, 249 million cases were reported in 2022 [1]. This infectious disease poses a serious risk to vulnerable populations, including young children, pregnant women, and their newborns. Malaria can lead to severe complications such as anemia and low birth weight, which contribute to high infant mortality rates [2].

Malaria is particularly prevalent and deadly in sub-Saharan Africa (SSA), where it remains a primary public health challenge for most countries. According to a recent WHO report, 94% of malaria infections reported globally originate from the WHO- Africa region [1]. The disease disproportionately affects young children in rural areas, where access to health care is limited or nonexistent [3]. The burden of malaria varies across different regions, countries, and communities within Africa.

In Ethiopia, malaria poses a significant public health issue, affecting the lives and livelihoods of millions. Approximately 75% of the country's land is prone to malaria transmission, exposing 52% of the population to the risk of malaria [4]. The primary *Plasmodium* species responsible for malaria in Ethiopia include *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae. Plasmodium falciparum* and *P. vivax* are the most prevalent, causing 60% and 40% of all malaria cases in the country, respectively [5]. It is estimated that about one million cases and tens of thousands of deaths are occur in the country annually.

Outbreaks typically occur following prolonged rainy seasons (from June to September), with peak incidence observed between September and November. In some regions, transmission can begin earlier during the light rain showers between April and May [4, 5, 6]. Elevations below 2000 m above sea level are particularly susceptible to malaria transmission, including the western and eastern lowlands as well as central highlands of the country. However, climate change has created favorable conditions for mosquito breeding, leading to increased malaria cases even in higher altitudes [5, 6]. The risk of malaria transmission is notably high in the western lowlands, encompassing parts of the Oromia, Amhara, and Tigray regions, as well as the Gambella and Benshangul Gumuz regions. Likewise, the two regions in the eastern lowlands, Afar and Somali, are endemic particularly along the riversides where extensive irrigation activities practiced [7].

Environmental factors such as temperature, humidity and altitude influence malaria transmission in Ethiopia, by creating conducive breeding conditions [7]. Recently, malaria transmission among communities living near irrigation sites has been on the rise [8]. Additionally, individuals with low socio-economic status are more vulnerable to malaria. Other significant determinants of malaria risk include drug resistance, human migration and the immune status of individuals [9].

This study aims to identify the key malaria transmission risk factors among children under five years old in the Gursum district of the Somali region in Ethiopia.

Methods

Study area setting

The study area is situated in a malaria-endemic region within the eastern low land part of Ethiopia, specifically in the Gursum district of the Somali region. Gursum is bordered to the west by the Oromia region, and to the north, south, and east by the districts of Ajersagora, Babille, and Jigjiga, respectively. The district comprises 18 administrative areas, locally known as 'kebeles', and is home to a total population of 37,821 as reported by the Central Statistical Agency of Ethiopia (CSA) in 2014 [10]. In this district, three health centers serve the population.

Study design

An institutional- based unmatched case- control study was conducted from June to July 2020. The study included under-five years old (U5) children who are permanent residents of the district and who visited the health centers where they were screened for malaria infection using microscopy and rapid diagnostic tests (RDTs).

Cases were defined as U5 children with one or more malaria symptom/s, and tested positive for *Plasmodium* species using RDTs/ blood film examination. U5 children with one or more symptom/s of malaria, but reported negative for blood film examination/ RDTs were considered as controls. U5 children who were not able to provide a written consent from their parents or caregivers were excluded from the both the cases and control group of the study.

Sample size determination

The sample size for this study was calculated using Epi-Info version 7.0, based on the following assumptions: an 80% power, a 95% confidence interval, a 5% margin of error, and a 1:2 case-to-control ratio. The final sample size was informed by a prior study in Dembia, North South Ethiopia, which examined travel history as a risk factor. In that study, 5.94% of the control group reported exposure, with an odds ratio of 3.7 as documented by Agegnehu et al. [11]. Considering the initially calculated sample size and including a 5% non-response rate, the study's final sample size was determined to be 257 participants. This included 86 cases and 171 controls, ensuring a robust and representative sample. The adjustment accounts for potential dropouts, thereby preserving the study's validity and reliability.

Data collection

The three health centers (HCs) in the district—Fafan HC, Bobas HC, and Qorea HC—were purposely selected for the study. The sample size, including both cases and controls, was proportionally allocated to each health center based on the monthly number of U5 children visiting these facilities. Specifically, 30 cases and 60 controls were recruited from Fafan HC, 31 cases and 62 controls from Bobas HC, and 25 cases and 49 controls from Qorea HC. All U5 children who tested positive for any *Plasmodium* species infection through blood film examination or RDTs were included as cases. For each case, two children testing negative for *Plasmodium* were selected as controls. In total, 86 U5 cases and 171 controls were recruited from the three health centers in Gursum district.

Following written consent, parents or caretakers were interviewed at the Under-Five Outpatient Department (U5OPD). Blood samples were tested for malaria using RDTs and microscopy by six trained laboratory technicians [6]. Malaria testing was conducted with the SD BIOLINE Malaria Ag *P.f/P.v* POCT test kit (Standard Diagnostics, Inc., Germany, Lot No. 145021), which detects antigens specific to *Plasmodium* species.

A standardized and pre-tested interviewer-administered questionnaire was used to gather data on socio-demographic characteristics, health-related knowledge, and malaria prevention practices. **Socio-demographic variables** included the child's sex and age (in months), household head's gender, caregiver's marital status, household income (monthly), and place of residence. **Knowledge-related variables** covered general health information, awareness about malaria and its prevention methods, malaria case history, and the caregiver's education level. **Prevention-related variables** included the availability and suitability of insecticide-treated nets (ITNs), insecticide spraying, nighttime use of mosquito nets, proximity to mosquito breeding sites, filling stagnant water, housing conditions (e.g., building materials, wall holes), and the availability of latrines.

Trained data collectors from the health centers conducted the interviews. The questionnaire was translated from English into local languages, including Somali, and back translated to ensure accuracy. For parents who struggled with reading or writing, a member of the investigation team assisted by translating the questions into their native language. All questionnaire data and RDT results were carefully compiled and cross-checked using subject identification numbers to ensure consistency and accuracy.

Data processing and analysis

Data control was conducted manually to ensure completeness and accuracy before being entered into the data entry tool, EpiData version 4.2. Following systematic data entry and cleaning, the dataset was transferred to the statistical software Stata version 15.0 for analysis.

During the bi-variable analysis, variables with a p-value of less than 0.05 were considered for inclusion in the multivariable analysis. Multivariable analysis was conducted to identify statistically significant associations between explanatory variables and the outcome variable (presence of malaria). Variables in the multivariable analysis were considered associated with the outcome if their p-value was less than 0.05. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated to quantify the strength of these associations. To ensure data quality and reliability, the data abstraction format was pre-tested on 5% of the sample size to validate the instrument. The pre-tested cases were excluded from the final analysis.

Ethical consideration

Ethical approval and clearance were obtained from the Department of Public Health at Jigjiga University. Permission was also secured from the relevant authorities at the Gursum district health office. Prior to conducting interviews and collecting blood samples, respondents' consent was sought, ensuring they were fully informed of their rights and the purpose of the study. Participants were assured of confidentiality, as no identifiable information such as names or addresses was collected, and their responses were recorded anonymously. Data were gathered in aggregate form to generalize attitudes toward malaria prevention measures.

The data collectors, who were health professionals, created a trusting and respectful environment, prioritizing participants' privacy and encouraging honest responses. Respondents were informed of their right to opt out of the survey at any stage without any obligation or need to provide a reason. Additionally, patients who appeared clinically unwell during the survey were advised to seek medical care at the nearest health facility.

Results

Study population demographics

A total of 247 participants, comprising 82 cases and 165 controls, were included in the study. Four cases and six controls were excluded from the analysis due to incomplete information or matching issues. Among the participants, the majority of children—55% of cases and 51% of controls—were male. The ages of the children were categorized into three groups: 1–24 months, 25–48 months, and over 48 months. Nearly half of the children in both groups (45% of cases and 42% of controls) belonged to the first age category of 1–24 months.

Among the household heads participating in the study, the majority (89%) were male, and a similar proportion (87%) were married. Additionally, three-quarters of the participants were urban dwellers, while the remainder resided in rural areas. Table 1 below outlines the socio-demographic characteristics of both the children and their household heads.

Knowledge, attitude and practice (KAP) of malaria prevention mechanism

Children from families that are well-informed about malaria prevention measures were less likely to experience malaria compared to those whose families had limited knowledge. Children in the second age group (25–48 months) were found to have a threefold higher risk of malaria infection, with a Crude Odds Ratio (COR) of 3.22 (95% CI: 1.84–5.61). Additionally, the use of malaria prophylaxis significantly reduced the risk of infection, with a COR of 2.96 (95% CI: 1.71–5.13). On the other hand, the literacy level of caregivers appeared to have a minimal effect on the risk of childhood malaria. Table 2 summarizes the findings regarding the KAP related to the causes and prevention of childhood malaria.

Preventive methods associated with childhood malaria

Children from households without ITNs were more than three times as likely to be exposed to the risk of childhood malaria compared to those whose caretakers reported using ITNs. Similarly, the presence of vector breeding habitats within the residential area appeared to increase the risk of malaria infection by five times. The bivariate analysis of key malaria risk factors in the study area is presented in Table 3 below.

Determinant factors for malaria under five age group: multivariate analysis

Each independent variable was adjusted in the final multivariate analysis by controlling for the effect of other variables. Children from rural areas were more than two times as likely to contract malaria [AOR = 2.10, 95% CI (1.14–3.85)] compared to children living in urban settings. Children living close to a water source were also more prone to malaria infection [AOR = 3.60, 95% CI (1.73–7.48)] compared to those living in areas without water source. Table 4 below summarizes the multivariate analysis of factors associated with childhood malaria.

Discussion

Malaria is a major health problem in Ethiopia, especially for vulnerable children under five. Research showed that malaria prevalence in under five children in Ethiopia is 22.03% [12]. This study found that children under five who lived with care givers who lacked malaria health knowledge, near malaria vector breeding sites and water source, and in houses with mosquito entry holes in their walls were at risk of getting malaria.

The study also found that rural children are more likely to have higher odds of malaria infection. This aligns with

Table 1 Socio-demographic characteristics of respondent Children and household heads (N = 247; cases: 82 and controls: 165)

Variables		Category	Cases N (%)	Controls N (%)	Total N (%)
Children	Gender	Male	45 (54.9)	84 (50.9)	129 (52.2)
		Female	37 (45.1)	81 (49.1)	118 (47.8)
	Age	1–24 Month	37 (45.1)	70 (42.4)	107 (43.3)
		25–48 Month	26 (31.7)	55 (33.3)	81 (32.8)
		> 48 Month	19 (23.2)	40 (24.2)	59 (23.9)
Household head or care giver	Gender	Male	68 (82.9)	151 (91.5)	219 (88.7)
		Female	14 (17.1)	14 (8.5)	28 (11.3)
	Marital status	Married	74 (90.2)	141 (85.5)	215 (87.0)
		Divorced/widowed	8 (9.8)	24 (14.6)	32 (13.0)
	Education	Literate	24 (29.3)	70 (42.4)	94 (38.1)
		Illiterate	58 (70.7)	95 (57.6)	153 (61.9)
Household income status(monthly)*		< 1500	34 (41.5)	68 (41.2)	102 (41.3)
		1600–3000	29 (35.4)	70 (42.4)	99 (40.1)
		> 3000	19 (23.2)	27 (16.4)	46 (18.6)
Residence		Urban	54 (65.9)	132 (80.0)	186 (75.3)
		Rural	28 (34.2)	33 (20.0)	61 (24.7)

*Currency in Ethiopian Birr (1USD = 56.97Birr)

Table 2 KAP of childhood prevention mechanisms (N = 247; cases: 82 and controls: 165)

Variables	Cases	Controls	Cor* (95% ci)	*P*-value
Health information				
Yes	34 (41.5)	92(55.8)	1	
No	48(58.5)	73(44.2)	1.78(1.04–3.04)	0.035
Knowledge of cause for malaria				
Yes	27(32.9)	75(45.5)	1	
No	55(67.1)	90(54.6)	1.697(0.97–2.95)	0.061
Prevention knowledge of malaria				
I know	27(32.9)	101(62.2)	1	
I don't know	55(67.1)	64(38.8)	3.22(1.84–5.61)	0.000
Prevention practices				
Prophylaxis	29(35.2)	102(61.8)	1	
No Prophylaxis	53(64.6)	63(38.2)	2.96(1.71–5.13)	0.000
Residence settings				
Urban	54(65.9)	132(80.0)	1	
Rural	28 (34.2)	33(20.0)	2.05(1.14–3.67)	0.000
Caregiver's education level				
Literate	24(29.3)	70(42.4)	1	
Illiterate	58(70.7)	95(57.6)	1.781(1.01–3.14)	0.046

**COR* Crude Odd Ratio

Table 3 Bivariate analysis of risk factors associated with childhood malaria (N = 247; cases: 82 and controls: 165)

Variables		Case N (%)	Control N (%)	COR* (95% CI)	*P*-Value
Availability of ITN	Yes	24 (29.3)	98 (59.4)	1	
	No	58 (70.7)	67 (40.6)	3.54(2.00–6.24)	0.000
Suitability of ITNs	Yes	23 (28.1)	40(24.2)	1	
	No	59(72.0)	125(75.8)	1.22(0.67–2.22)	0.518
Spraying insecticide	Yes	30(36.6)	66(40.0)	1	
	No	52(63.4)	99(60.0)	1.16(0.67–2.00)	0.604
Using/practicing of ITNs	Yes	27(32.9)	53(32.1)	1	
	No	55(67.1)	112(67.9)	1.04(0.59–1.82)	0.899
Vectors breeding sites	Yes	65(47.8)	71(52.2)	5.06 (2.73–9.38)	0.000
	No	17(15.3)	94(84.7)	1	
Source of water in proximity	Yes	62(75.6)	65(39.4)	4.77(2.64–8.63)	0.000
	No	20(24.4)	100(60.6)	1	
Material house walls made of	Cement & metal	44(53.7)	87(52.7)	1.04(0.61–1.77)	0.890
	Woody & mud	38(46.3)	78(47.3)	1	
Hole on the wall	Yes	66(80.5)	85(51.5)	3.88(2.08–7.26)	0.000
	No	16(19.5)	80(48.5)	1	
Latrine availability	Yes	32(39.0)	57(34.6)	1	
	No	50(61.0)	108(65.5)	1.21(0.70–2.10)	0.490

**COR* Crude Odd Ratio

findings from other studies conducted in different parts of Ethiopia [13] and in other African countries, where malaria prevalence was higher among rural children compared to urban children in Kenya [14], Uganda [15], and Rwanda [16]. The higher risk in rural areas could be attributed to environmental factors, as these areas often provide more favorable conditions for mosquito breeding. Stagnant water, poor drainage systems, and thick vegetation create ideal breeding sites for mosquitoes. Additionally, rural areas tend to have limited access to

Table 4 Final multivariate analysis of factors associated with childhood malaria (N = 247; cases: 82 and controls: 165)

Variables	Case, N (%)	Control, N (%)	COR (95%CI)*	AOR (95%CI)+	*P*-value
Residence					
Urban	54 (65.9)	132 (80.0)	1		
Rural	28 (34.2)	33 (20.0)	2.05 (1.14–3.67)	2.10 (1.14–3.85)	0.003
Information about malaria					
Yes	34 (41.5)	92 (55.8)	1		
No	48 (58.5)	73 (44.2)	1.78 (1.04–3.04)	1.75 (1.00–3.06)	0.031
Vector breeding habitat					
Yes	65 (47.8)	71 (52.2)	5.07 (2.73–9.38)	4.74 (2.27–9.90)	0.000
No	17 (15.3)	94 (84.7)	1		
Hole on the wall					
Yes	66 (80.5)	85 (51.5)	3.88 (2.08–7.26)	5.00 (2.22–11.28)	0.000
No	16 (19.5)	80 (48.5)	1		
Proximity to source of water					
Yes	62 (75.6)	65 (39.4)	4.77 (2.64–8.63)	3.60 (1.73–7.48)	0.000
No	20 (24.4)	100 (60.6)	1		
Availability of latrine					
Yes	32 (39.0)	57 (34.6)	1		
No	50 (61.00)	108 (65.5)	1.21 (0.70–2.10)	2.59 (0.71–9.44)	0.147

**COR* Crude Odd Ratio

+ *AOR* Adjusted Odd Ratio

healthcare facilities, which means that people in these areas may face difficulties in accessing timely malaria diagnosis and treatment services. Delayed or inadequate treatment can contribute to higher rates of infection. Socioeconomic factors also play a role, as rural populations generally have lower socioeconomic status than their urban counterparts. Poverty often leads to poor housing, limited access to mosquito control measures like ITNs, and inadequate preventive care such as anti-malarial medications. Furthermore, rural populations typically have less access to education and healthcare information, which can result in lower awareness of malaria prevention strategies, such as the use of bed nets, indoor residual spraying, and the importance of seeking medical care early. Higher levels of education and awareness in urban areas generally contribute to better adherence to preventive measures and earlier detection and treatment of malaria cases.

Children living near malaria breeding areas and close to sources of water face a significantly higher risk of contracting malaria compared to those living in other areas. Water sources create favorable conditions for the breeding of *Anopheles* mosquitoes, which are the primary vectors of malaria. In Ethiopia, *Anopheles arabiensis*, the most common malaria-carrying mosquito, is typically found in breeding habitats such as temporary pools, puddles, and swamps. These breeding sites are often located in rural and periurban areas [17], where children are more likely to be exposed to the risk of malaria transmission. Recent studies in the Somali Region, particularly in urban areas like Jigjiga, which is near Gursum, have highlighted the rapid spread of the invasive *Anopheles stephensi* species. This mosquito species can breed in a wide range of habitats, including artificial water-holding containers such as cisterns, water tanks, barrels, and construction pits [18]. The establishment of *Anopheles stephensi* in these areas contributes to an increase in the density of the malaria vector, thereby raising the probability of mosquito bites among children. As a result, the likelihood of malaria transmission is amplified. This finding is consistent with studies conducted in other parts of Ethiopia [12, 19–21], which show that mosquito breeding habitats—such as stagnant water in marshy environments or trees near residential houses—are significant risk factors for malaria transmission. Research conducted in Wogera district and Laelay Adyabo also supports the idea that malaria vector density and proximity to water bodies, like rivers and streams, are important factors influencing malaria transmission [21, 22].

Housing plays a significant role in malaria prevention, particularly in areas where the disease is endemic. The design and construction of houses can impact their vulnerability to mosquito entry. Well-constructed homes with screened windows and doors, tight-fitting eaves, and properly sealed walls can reduce the entry of mosquitoes into living spaces [23], thereby lowering the risk of malaria transmission indoors. Proper housing also provides a structure for ITNs or long-lasting insecticidal nets (LLINs) over sleeping areas. Additionally, houses with smooth, easily cleanable walls are essential for the effective implementation of IRS [24]. Families whose homes have holes in the walls, allowing mosquito entry, are at a higher risk of malaria infection compared to those with intact walls [24]. This is supported by evidence showing that children living in houses with mosquito entry points, such as holes in the walls, are more likely to contract malaria, a finding consistent with similar studies [25–28].

Several structural deficiencies in houses can facilitate the entry of mosquitoes, including a lack of screening and poorly fitting external doors, which create opportunities for mosquitoes to enter during the night [29]. Simple modifications, such as eave screening, have been shown to significantly reduce the indoor presence of both *Anopheles* and *Culex* mosquito species [30]. Improving house structure can limit contact between humans and mosquitoes, thereby reducing the risk of malaria transmission. This study highlighted that certain house characteristics, such as the presence of holes in walls, open eaves, unscreened windows, and proximity to breeding sites, contribute to the higher likelihood of mosquito presence in homes. These factors are consistent with findings from other studies, which demonstrate how structural improvements can reduce mosquito entry and, in turn, lower the risk of malaria [26, 27, 31].

The health and growth of a child are closely linked to the education of the caregiver, particularly the mother. This study found a significant association between the likelihood of malaria infection and the mother's education level in Gursum district. This finding is consistent with previous research, which has shown that higher education and increased malaria knowledge are positively correlated with greater ownership of mosquito nets by households [11]. A possible explanation for this is that more educated and knowledgeable caregivers are better equipped to access information about malaria prevention and are more likely to adopt practices that protect their children, including proper use and maintenance of the nets they receive.

The results of this study indicate that children of caregivers who had received health information about malaria were less likely to contract the disease compared to those whose caregivers had not received such information. This finding is consistent with studies conducted in various parts of Ethiopia [32], suggesting that access to health information about malaria can have a protective effect against infection. Additionally, knowledge of malaria prevention methods is a crucial factor in reducing malaria transmission among children under five. Children from households lacking awareness of malaria prevention strategies were found to be more likely to be infected, a pattern also observed in another study [21].

One of the most effective methods to prevent malaria infection is the use of ITNs. However, many people living in malaria-endemic areas lack access to ITNs or fail to use them consistently. A study conducted in Ethiopia [19] found that children living in households without ITNs were at a higher risk of malaria infection compared to those in households with ITNs, with the difference being statistically significant. This finding contrasts with a study conducted in Ghana, which did not find a significant association between ITN ownership and malaria infection [33]. Additionally, the Ethiopian study highlighted the scarcity of ITNs and other malaria prevention tools as a major challenge for malaria control in the country, a challenge that is also reflected in another study conducted in Arba Minch [21].

Limitations

This study has several limitations. It did not include all health centers in the districts due to constraints in logistics and finances, which may have led to sampling bias and limited the generalizability of the findings to all households in the districts. Another limitation is the method of case ascertainment, as malaria cases were diagnosed using RDTs, which may not be 100% sensitive or specific. As a result, there could have been misclassification of cases and controls, potentially affecting the accuracy of the study's conclusions.

Conclusions

This study investigated factors influencing malaria infection risk among children under five in the Gursum district, Somali region, Ethiopia. It identified that sociodemographic factors—such as residence in rural areas with limited awareness of malaria prevention and proximity to water sources conducive to mosquito breeding—significantly increased malaria transmission risk. To address these findings, it is recommended that public health interventions to mitigate malaria burden in this population. Key actions include strengthening community engagement and health education to improve knowledge and preventive practices around malaria, eliminating or avoiding potential mosquito breeding sites, and prioritizing the provision of ITNs for families with young children. Health education initiatives should be accessible to all community members, including those with low literacy levels, and preferably delivered in local languages to ensure comprehensive reach and impact.

Abbreviations

HC	Health centre
INT	Insecticide-treated nets
KAP	Knowledge attitude and practice

RDT Rapid diagnostic test
U5 Under five years

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Author contributions
DEG: conceptualizing the study, design, collect the data, data analysis, and manuscript preparation. AM: conceptualizing the study, data analysis and writing manuscript AD: interpreted the data, writing manuscript, KD: interpreted the data, critically reviewed and writing manuscript AC: interpreted the data, critically reviewed and writing manuscript SY: conceptualizing the study, design, collect the data, data analysis, and manuscript preparation. All authors read and approved the final manuscript.

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Declarations

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Competing interests
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