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

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Research Article

Keywords: Children, Ethiopia, Malaria, Mosquito, Risk-factors

Posted Date: June 10th, 2024

DOI: https://doi.org/10.21203/rs.3.rs-4480877/v1

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Additional Declarations: No competing interests reported.
Abstract

Background

Despite the significant investments to control malaria infections over the past years, new infection rates remain significant public health problem in sub-Saharan Africa including in Ethiopia. This study aims in investigating key determinant of malaria infection among under five years (U5) children in Gursum district of Somali region, East Ethiopia.

Method

An institutional based case-control study was conducted for two months between June to July 2020. The study comprised 247 participants, divided into 82 cases and 165 controls, maintaining 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 located in the district. The investigation included identifying plasmodium species using rapid diagnostic tests and microscopic blood film examination. Logistic regression model was used to identify the factors influencing the outcome, using a statistical software STATA-13/15. Odds ratios and the corresponding confidence intervals were used to identify potential predictors in logistic regression model.

Results

A multivariate analysis disclosed the following five exposures to be significantly associated with malaria positivity among children. Those are, being-living near to source of a stagnant water [AOR = 3.60 (1.73–7.48)], in rural area [AOR = 3.58 (1.56–8.21)], in a house with openings or holes on the wall for mosquito entry [AOR = 5.00 (2.22–11.28)], and not receiving malaria health information [AOR = 2.12 (1.06–4.21)]. In addition, household being near to malaria breeding habitat [AOR = 4.74 (2.27–9.90)] was significant with malaria positivity. These are the top five key determinant of malaria positivity among U5 children the Gurum district.

Conclusion

The study revealed that the most pressing determinant for malaria positivity among U5 in the Gurum district seems to be related to unawareness, housing and spatial proximity to breading sites. Therefore, social mobilization, and spatially targeted malaria interventions are essential to reduce the transmission of the disease at the community level, especially among the most vulnerable children.

BACKGROUND
According to the latest report of the World Health Organization (WHO) global malaria estimation, 249 million cases were reported in 2022 (1). This infectious disease poses a serious risk to vulnerable populations, such as young children, pregnant women, and their newborns. Some of the common complications of malaria include anemia and low birth weight, which contribute to high infant mortality rates (2).

Malaria is especially prevalent and deadly in sub-Saharan Africa (SSA), where it persists to be the main public health challenge for majority of the countries. The recent report of the WHO shows that, most of the infections reported globally (94%) are 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.

Malaria is a major public health problem in Ethiopia, where it affects the lives and livelihoods of millions of people. About 75% of the land area is in favor of malaria transmission. Hence, 65% of the population are exposed to the risk of malaria. The prominent Plasmodium Species for malaria in Ethiopia are, *P. falciparum, P. vivax, P. ovale* and *P. malariae*. The former two (*P. falciparum and P. vivax*) are the most widespread species, and causing 60% and 40% of all malaria in the country respectively (4). It is estimated, that annually, about one million of cases and tens of thousands of deaths are reported in the country.

Outbreaks usually occur after prolonged rainy seasons (from June to September), with peak incidence between September and November. In some areas, transmission of may still appear earlier during the light rain shower months between April and May (5). Elevations below 2000 meters above sea level are prone to high risk of malaria transmission, namely; western and eastern lowlands and central highlands of the country. However, due to climate change, which created a favorable condition for mosquito breeding transmission of mosquito-borne parasites such as malaria, recent years have witnessed malaria cases even in higher altitudes (4, 5). Country wise, transmission risk is high in the western lowlands, including parts of Oromya, Amhara, Tigray regions, 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 (6).

Environmental factors such as temperature, humidity and altitude, impact on the transmission in Ethiopia, by creating conducive situation for the breeding sites (6). Recently, malaria transmission among communities living near irrigation sites is on a raise (7). Moreover, people with low socio-economic status are more vulnerable to malaria. Other important determinants of malaria risk include drug resistance, and human migration and immune status of individuals (8).

Therefore, this study aims to identify the key malaria transmission risk factors among children under 5 years old in the Gursum district of the Somali region in Ethiopia.

**MATERIAL AND METHOD**
Study area setting

The study area is located within the premises of malaria-endemic area of the eastern low land part of Ethiopia, known as the district of Gursum area of the Somali region. Gursum borders in the west with the Oromia region, in the north, south, and east it border with districts, Ajersagora, Babille, and Jigjiga of the Somali region respectively. There are 18 administrative areas (locally known as ‘kebeles’), inhabited by a total population of 37,821 according to the Central Statistical Agency of Ethiopia’s (CSA) reported in 2014 (9). In this district there are three health care facilities or health centers serving the population.

Study design

An institutional based unmatched case control study was conducted from June 2020 to July 2020. Under-five years old (U5) children who are permanently resident of the district, and visited the health centers, and screened for malaria infection using microscopy and rapid diagnostic tests (RDT) were included in the study.

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 where excluded from the both the cases and control group of the study.

Sample Size Determination

The study's sample size was determined through EpiInfo version 7.0, assuming a power of 80% and a 95% confidence interval. A margin of error was set at 5%, with a case to control ratio of 1:2. This study's final sample size was derived from a previous study conducted in North South Ethiopia, Dambia, which considered travel history as a factor. In that study, 5.94% of the control group was exposed, with an odds ratio of 3.7, as reported by Agegnehu and colleagues (10). Taking into account the previously determined sample size and incorporating a 5% non-response rate, the study's final sample size was established at 257 participants, comprising 86 cases and 171 controls. This adjustment ensures a more accurate representation and accounts for potential dropouts, thereby maintaining the study's validity.

Data collection

The three health centers (HC) in the district; namely Fafan HC, Bobas HC, and Qorea HC were selected purposely. Based on the number of U5 children who visited the respective health centers on a monthly base, sample size (for both cases and controls) was proportionally allocated to each health center. From Fafan health center (30 cases and 60 controls), from Bobas health center (31 cases and 62 controls), and from Qorea health center (25 cases and 49 controls) samples were collected. All U5 children confirmed positive for any Plasmodium specifies infection tested with blood film examination/ RDTs were selected. For every child confirmed positive with any plasmodium species infection, two negatives
were selected as controls. Hence, in total, from the selected three HCs in Gurusum district, for 86 U5 children cases, 171 control U5 children recruited for the study.

Following their written consents, parents/caretakers were interviewed at the U5 children Out Patient Department (U5OPD). Blood samples were tested using an RDTs and microscope by trained laboratory technicians (5). For malaria parasite testing, by capturing the antigens, RDTs were performed using the SD BIOLINE Malaria Ag *P.f/P.v* POCT test kit (Standard diagnostic, Inc, Germany, Lot No. 145021) (11). A standardized and pre-tested questionnaire was used to collect information on variables related to socio-demographic conditions, heath and allied knowledge, and prevention methods used. **Socio-demographic variables** includes, child sex, child age in month, household head gender, marital status of care giver’s, household income (monthly), residence, and others. **Knowledge related variables** were, health information in general, knowledge about malaria and its prevention methods, malaria case, and educational level of caregiver. Among the **prevention and related variables** included, availability of insecticide treated nets (ITNs), suitability of ITNs, spraying insecticide, sleeping under mosquito net during night time, presence of malaria vectors breeding habit, proximity to stagnant water, filling stagnant water, types of housing (building materials), presence of hole on the wall of house, and availability of latrine. Qualified, and trained data collectors from the health centers conducted the interviews. The questionnaires were translated from English into local languages such as Somali and others, and back-translated. All subject questionnaire data and RDT results were compiled and cross-checked using subject identification numbers.

**Data processing and Analysis**

Data control conducted manually to check for its completeness and its rigor, and then feed into data entry tool, Epi-data 4.2 version. After systematic data entry and cleaning, the data transferred into data analysis too, Stata version 15.0 for analysis.

During bi-variable analysis, variable with P-value < 0.05 were consider for multivariable analysis. Multivariate analysis was done to determine the presence of a statistically significant association between explanatory variables and the outcome variables (presence of malaria). Explanatory variables were considered associated with the outcome variable in the multivariable analysis at (P< 0.05). Adjusted Odds ratios (AORs) and their 95% confidence intervals (95% CI) were calculated to show strength of association.

To optimize data quality and management, data abstraction format was pre-tested in 5% of the sample size to check the validity of the data. The pre-tested patients were excluded from the analysis.

**Ethical Consideration**

The ethical approval and clearance were obtained from Department of Public health Jigjiga University. Permission was also acquired from the Gurusun district health office’s concerned bodies. The consent of the respondents was sought before to the interview and collection of blood sample. Respondents were informed that the information they supplied was confidential, in that their actual names and addresses
were not collected. Hence, their responses were anonymous collected. Data were collected in aggregate form in order to generalize their attitudes on malaria prevention measures. Data collectors were health experts who built a trusting environment by respecting participants’ privacy, which can encourage them to be completely honest during the survey. They had the option of not participating in the survey, and even to drop in the middle of the survey, anytime without further obligation and reasoning out. Patients who were clinically unwell at the time of the survey were advised to seek medical help from a nearby health facility.

RESULTS

Study population demographics

Total of 247 (82 cases and 165 controls) under five children were included. Four cases and six controls were excluded from the analysis due to incomplete information or matching problem. Majority of the children, 55% and 51% from cases and controls respectively, were males. The age of the study participant children was categorized into three groups, namely; first group (including 1–24 months old), second group (25–48 months old), and the rest in the third group (greater than 48 months old). Nearly half of both the study children (45% from cases and 42% from control) were within the first group.

Among the household head participants, majority (89%) were males. Similarly, the majority (87%) of the respondents among the household heads were married. Three-fold of the participants were urban dwellers, and the rest were rural dwellers. Table 1 below presents the socio-demographic statues of study participants of both children and household head.
Table 1
Socio-demographic characteristics of respondent Children and household heads (N = 247; cases: 82 and controls: 165).

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

* Currency in Ethiopian Birr (1USD = 34.7Birr)
Knowledge, Attitude and Practice (KAP) of malaria prevention mechanism

Children from families who are well acquainted with malaria prevention mechanisms were less likely to encounter malaria, as compared to their compatriots whom their families had no clue at all. Children from the second group had three fold risk of malaria infection [Crude Odd Ratio (COR) = 3.22, 95% CI (1.84–5.61)]. For example, the preventive medication, malaria prophylaxis usage was found to significantly lower [COR = 2.96, 95% CI (1.71–5.13)]. On the other hand, literacy of caregivers seems to have nearly insignificant effect on the risk of childhood malaria. Table 2 summarizes the analysis about the KAP effect in causes and prevention of childhood malaria.

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

* COR = Crude Odd Ratio

Preventive methods associated with childhood malaria

Children from households without Insecticide Treated Net (ITN) were more than three times exposed to risk of childhood malaria as compared to those who sleep under ITN. Similarly, vector breeding habitat
within the residential area also seems to increase the risk of malaria infection by five-folds. The bivariate analysis of key malaria risk factors of the study area are presented in Table 3 below.

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

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

* COR = Crude Odd Ratio
Determinant factors for malaria under five age group: Multivariate analysis

Each independent variable was adjusted for final multivariate analysis by controlling the effect of the other variables. Children from the rural area were more than two times \([\text{AOR} = 2.10, 95\% \text{CI} (1.14-3.85)]\) likely to have contract malaria as compared to their counterpart children living in urban settings. Children living close to source of stagnant water were more prone to malaria infection \([\text{AOR} = 3.60, 95\% \text{CI} (1.73-7.48)]\) relative to those living in area without no stagnant water. Table 4 below summarizes the multivariate analysis of factors associated with childhood malaria.

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

* COR = Crude Odd Ratio

†AOR = Adjusted Odd Ratio
DISCUSSION

In Ethiopia, malaria continues to be a significant public health concern, particularly affecting vulnerable children under the age of five. Evidence showed that the prevalence of malaria among children under five years of age in Ethiopia was 22.03% (12). Main findings of this study showed that children under five, living with caregivers with inadequate malaria-related health information, residing close to the presence of malaria vector breeding habitat and in proximity to stagnant water, and those lodge in houses with openings for mosquito entry in their walls were at risk for malaria transmission.

In addition, our findings disclosed that children living in rural areas have increased odds of malaria infection. This is consistent with the finding of another study conducted earlier in other parts of Ethiopia (13) and in other African countries, where malaria prevalence was found to be higher among rural children compared to urban children in Kenya (14), in Uganda (15), and in Rwanda (16). This could be due to the fact that, rural areas often have more favorable environments for the breeding of mosquitoes. Factors such as stagnant water, lack of proper drainage systems, and dense vegetation provide ideal breeding grounds for mosquitoes. Rural areas typically have limited access to healthcare facilities compared to urban areas. This means that people living in rural areas may face challenges in accessing malaria diagnosis and treatment services promptly. Delayed or inadequate treatment can result in higher rates of infection. Rural populations often have lower socioeconomic status compared to urban populations. Poverty can contribute to factors such as inadequate housing, lack of access to mosquito control measures such as insecticide-treated bed nets, and limited access to preventive measures like antimalarial medications. Urban populations generally have better access to education and healthcare information compared to rural populations. This includes knowledge about malaria prevention strategies such as using bed nets, indoor residual spraying, and seeking prompt medical care. Higher levels of education and awareness can lead to better adherence to preventive measures and earlier detection and treatment of malaria cases.

Children living in the vicinity of malaria breeding areas and close to sources of stagnant water are at a significantly higher risk of contracting malaria than those living in other areas. Stagnant water creates a favorable condition for breeding of Anopheles mosquito, a malaria vector. This facilitates in the increment of the density of the vector itself, and the probability of mosquito bites to children, which in-turn scales up the likelihood of malaria transmission among those children. This is supported by a study conducted in Ethiopia (12, 17–19). Mosquito breeding habitats, including stagnant water (marshy environments) or trees near residential houses, are risk factors for malaria transmission as reported in previous studies in Wogera district, Laelay Adyabo (19, 20). Malaria vector density and living in the nearest proximity of water body, like river and streams could be an important factor influencing malaria transmission.

Housing plays a significant role in malaria prevention, particularly in areas where the disease is endemic. The design and construction of houses can affect their susceptibility to mosquito entry. Well-constructed houses with screened windows and doors, tight-fitting eaves, and properly sealed walls can reduce the
entry of mosquitoes into living spaces (21), thereby lowering the risk of malaria transmission indoors. Proper housing provides a structure to hang insecticide-treated bed nets (ITNs) or long-lasting insecticidal nets (LLINs) over sleeping areas. Proper housing structures with smooth, easily cleanable walls are necessary for effective IRS implementation (22). Families whose household walls have holes for mosquito entrance were more likely vulnerable when compared with no hole on the house wall (22). Evidence from increased malaria infection among children living in houses with mosquito entry opening holes on the their walls is in line with other similar studies, such as (23–26). Several structural deficiencies on houses that could allow entry of mosquitoes were found such as lack of screening, and external doors not fitting perfectly into walls hence potential for mosquito entry at night (27). Simple house modification by eave screening has the potential to reduce the indoor occurrence of both Anopheles and Culex mosquito species (28). Improving house structure is known to limit contact between humans and mosquitoes, and hence, reduces risk of malaria transmission. Our study indicated that several house characteristics such as, the presence of holes on walls, opened eaves, unscreened window and living close to breeding sites, favored mosquito presence in houses (24, 25, 29).

The health and growth of the child depend on the education of the caregiver (mother), as this study demonstrated a significant association between the likelihood of malaria infection and the mothers’ education level in Gursum district. This finding is consistent with previous studies that have indicated that higher education and malaria knowledge positively influence the ownership of nets by households (30). The possible explanation for this is that, more educated and knowledgeable people can access information about how to prevent malaria, and adopt better practices to protect and use the nets they receive.

The results indicate that participants who had received health information about malaria were less likely to have malaria than those who had not, with a COR of 1.78 and a 95% CI of 1.04–3.04. This evidence supported by study done in different part of Ethiopia (31). This suggests that health information about malaria may have a protective effect against malaria infection. Knowing malaria prevention mechanisms is another determinant factor for malaria transmission among children under five. Children whose households don’t know the prevention ways were more likely to be infected with malaria as reported in other studies as well (19).

One of the most effective ways to prevent malaria infection is to use insecticide-treated nets (ITNs). However, many people in malaria-endemic areas do not have access to ITNs or do not use them regularly. A study conducted in Ethiopia (17) found that children who lived in households without ITNs had a higher risk of malaria infection than those who lived in households with ITNs, and this difference was statistically significant. This result contradicts some previous studies that did not find a significant association between ITN ownership and malaria infection (32). The study also highlighted the scarcity of ITNs and other malaria prevention tools as a major challenge for malaria control in Ethiopia, which is consistent with another study done in Arba-minch (19).
This study has its own limitation it will not cover all health centers that are found in the districts due to lack of logistics and finance. One of the limitations is the case ascertainment, some of the children are tested using RDT, which might not be 100% sensitive and specific. Due to this there might be misclassification of cases and controls. However, the study results would not affected by this limitation and the samples taken from three health center can be representative the districts.

CONCLUSIONS

We conducted a study to examine the factors that influence the risk of malaria infection among children under five years old in the Gusum district of the Somali region in Ethiopia. We found that socio-demographic variables, such as living in rural areas with low awareness of malaria prevention and control, and residing near water sources that facilitate mosquito breeding, increased the likelihood of malaria transmission. Therefore, we recommend public health interventions that aim to reduce the malaria burden in this population, such as enhancing public knowledge and attitudes about malaria and how to prevent it through community engagement and health education, eliminating or avoiding potential mosquito habitats in the environment, and providing insecticide treated nets (ITNs) especially for young children.

List Of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC</td>
<td>Health center</td>
</tr>
<tr>
<td>INT</td>
<td>Insecticide treated nets</td>
</tr>
<tr>
<td>KAP</td>
<td>Knowledge attitude and practice</td>
</tr>
<tr>
<td>RDT</td>
<td>Rapid diagnostic test</td>
</tr>
<tr>
<td>U5</td>
<td>Under five years</td>
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</table>

Declarations

Consent for publication

NA

Availability of data and materials

NA

Competing interests

The authors declare that they have no competing interests.
Funding

NA. This study was no financially supported by any organization.

Authors’ contribution

DEG: conceptualizing the study, design, collect the data, data analysis, and manuscript preparation.

AM: conceptualizing the study, data analysis and writing manuscript

AD: interpretation 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.

Acknowledgements

We extend our gratitude to the health centers that facilitated our access to samples. We are immensely grateful to the dedicated health workers for collecting the blood samples and identifying the plasmodium species in the district for their service in these facilities.

References


