

ORIGINAL ARTICLE**Prevalence and Associated Factors of Malaria among Febrile Children in Afar Region, Ethiopia: A Health Facility Based Study****Abay Woday^{1*}, Ahmed Mohammed², Abel Gebre¹, Kusse Urmale³****OPEN ACCESS**

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ABSTRACT

BACKGROUND: Malaria is a major public health problem in Sub-Saharan Africa including Ethiopia and it affects children under five and pregnant mothers. The prevalence of malaria is not well studied though the burden is expected to be high in low lands of Afar region. Therefore, this study attempts to assess the prevalence and associated factors of malaria among under five children in the pastoral community.

METHODS: Cross-sectional study design was employed from April 15th to 15th May 2018 on a sample of 484 under-five children who visited the randomly selected health facilities of Dubti district, Afar region. The study participants were recruited randomly with the basic assumption that their arrival at health facilities is random. The main outcome variable was parasitological confirmed malaria among under five children and it was measured using either microscopy blood film examination. Binary logistic regression model was done to measure the association between confirmed malaria infection and its predictors. Independent variables with p-value less than 0.25 in the bivariate analysis were entered into multivariable logistic regression analysis model. Statistical significance level was declared at p-value less than 0.05.

RESULTS: The prevalence of malaria among febrile under-five children was 64% (95% CI 59.5%-68.4%). Of these, more than half (66.5%) and one-fifth (22.2%) of the cases were caused by *P. falciparum* and *P. vivax* respectively. The multivariable logistic regression analysis showed that living in rural residence [AOR=1.77: 95% CI 1.10-2.85], having educated mother [AOR=0.406: 95% CI 0.26-0.63], age of child ([AOR=2.98: 95% CI 1.41-6.32], sex of child [AOR=1.99: 95% CI 1.29-3.08], not sleep under ITN [AOR=9.10: 95% CI 1.01- 82.58], ITN availability [AOR=2.23: 95% CI 1.01- 4.89] and history of malaria infection among family members [AOR=9.10: 95% CI 1.01-82.58] were the independent predictors of malaria infection among under five children.

CONCLUSION: The overall prevalence of malaria among under-five children was high compared to the national prevalence of malaria among the general population. Health care providers (HCPs) should educate parents/guardians regarding proper utilization of ITN at night. In addition, they should provide early treatment for febrile family members to halt the transmission of malaria. The regional government should give due attention to supply of ITN and enhance the awareness of the community. Additional longitudinal studies are recommended.

KEYWORDS: Prevalence, Associated factors, Malaria, Febrile Under five children, Ethiopia

INTRODUCTION

Malaria is a public health problem worldwide, and it causes more than 216 million (95% CI: 196–263 million) cases per year. Of these malaria cases, more than 90% of are found concentrated in sub-Saharan African countries including Ethiopia (1). Moreover, in 2016, nearly half million (429 000) deaths were caused by malaria, and more than 92% of these happened in sub-Saharan African countries (2).

Even though household ownership of at least one ITN was increased from 50% to 80% in sub-Saharan African countries, the proportion of households with sufficient nets (i.e. one net for every two people) remained inadequate (43%) (1). Furthermore, malaria is still the leading public health problem among sub-Saharan countries including Ethiopia; it predominately affects pregnant mothers and under-five children (3). In Ethiopia, three-fourth of the areas are malaria endemic, and more than two-thirds of its population (more than 55 million people) live in areas of risk for malaria (4, 5). According to the 2013 health and health related indicator report of the Ministry of Health (MOH), malaria was one of the ten top leading causes of morbidity (12%); 2.85 million blood film-confirmed malaria cases were reported from different parts of the country (6).

Globally, regionally as well as nationally different strategies, policies and malaria elimination programs were tried in the last decades (7-10). Over 6.2 million malaria deaths were averted between 2000 and 2015 in sub-Saharan Africa (11). However, the 2015 target of MDG was not met (reduce the incidence rate by 50%)(12). Despite the significant decline in the burden of malaria, the disease is still one of the major public health concerns Ethiopia (13). Furthermore, the prevalence of malaria among under-five children ranges between 0.56% and 53.6% in the country (4, 14-18).

Previous studies conducted across sub-Saharan African countries to assess the factors associated with malaria endemic identified various factors for the occurrence of malaria endemic among under-five children. The identified factors include sex of the child, age of the child, number of bed nets available for the household members,

presence of forest cover, altitude of the residence, household density (family size) and housing conditions (4,5,15,17,19,20).

Afar Region is the most lowland area in Ethiopia, and more than 80% of its population are at risk for malaria infection, especially under-five children and pregnant women (21). According to the Health Sector Development Plan IV performance (HSDP IV) report, the incidence of malaria in Afar Region was 3,479 cases per 100,000 people (16). Furthermore, according to the 2016 Ethiopian Demographic and Health Survey (EDHS) report, the region has the highest under-five mortality rate compared to other regions (125 deaths per 1000live births) (22). In addition, only 33% of children under the age of five were sleeping under insecticide treated nets in Ethiopia including Afar Region (23). Therefore, malaria may be responsible for the highest under-five mortality rate in Afar Region.

Moreover, no study has been conducted to date to address the prevalence and associated factors of malaria among under-five children in Afar Region. Therefore, this study aims to assess the prevalence and associated factors of malaria among under-five children and to fill the identified information gaps in the region.

METHODS AND MATERIALS

Study setting and participants: Institution based cross sectional study design was employed to assess the prevalence and associated factors of malaria among under-five children getting medical cares in Dubti District public health facilities from 15th April to 15th May 2018. The district is located 588kms away from the capital city, Addis Ababa. It has a total population of 72,528. Of these, 5,950 are under-five children. The area has 800-1000 meters' altitude above sea level, and it has manmade dam around. The district has four health centers, one referral hospital, fourteen health posts, and three private pharmacies.

All under-five children who presented with fever symptoms and gave blood for microscopic blood film examination or RDT at the randomly selected public health facilities were included in this study. However, children with critically sick care givers/guardians and those who presented to the health facilities without being accompanied by

their nearest parents/caretakers were excluded from this study (i.e. children coming with the neighbors or friends).

The sample size was calculated using single population proportion formula with the basic assumptions of 95% Confidence interval for the Critical value $Z_{\alpha/2} = 1.96$ and 4% margin of error. A 25% prevalence (P) of malaria among the general population was taken from a study done in East Oromia [5]. After adding 10% to compensate the non-responses ($450 \times 0.1 = 45$), the final sample size became 495.

Two health facilities were selected randomly from a total of five health facilities those have functional blood film examination services. The samplee were proportionally allocated into selected health facilities based on malaria case flows they had in the last one-year. The children were assumed to arrive at selected health facilities at random; they were recruited based on their arrival with the inclusion criteria. The data was collected by including all febrile children until the maximum sample size was satisfied. The mothers/caregivers were interviewed about the consistent symptoms of malaria (fever), and final confirmation was done with blood film or RDT results.

Data collection: Standardized, pretested and structured interviewer-administered questionnaire was used to collect data. The questionnaire was developed in English on socio-demographic characteristics, health service related factors, environmental factors, ITN availability and utilization. Two-laboratory technicians and a supervisor from Dubti Hospital were trained for two days on the data collection instrument, interview techniques and recruitment of the study participants.

The tool was pre-tested on 5% of sample and some amendments were made. The questionnaire was translated into local language (Afar-aaf) and back into English to check for consistency.

Malaria diagnosis was confirmed using the laboratory results done with microscopic blood films prepared from finger-prick blood samples or RDT results collected from malaria suspected children. Experienced laboratory technicians prepared thick and thin blood films that were labeled and air-dried horizontally in a slide tray.

Thin films were fixed with methanol for about 30 seconds, and both thick and thin films were stained with 3% Giemsa for 20–30 minutes at the study health facilities by using the WHO 2015 standard malaria laboratory procedures guideline (24). The thick films were used for detecting the malaria parasites while the thin films were used for label and for species confirmation. The blood slides were read and then classified qualitatively as either negative, *P.falciparum* positive, *P.vivax* positive, or mixed infection. Children with microscopically confirmed malaria infections were treated at the health facilities according to the national malaria diagnosis and the national malaria treatment guidelines.

Data management and analysis: Data entry, data cleaning and data coding were performed using the Epi data version 3.1 and then exported to SPSS version 20.0 for analysis. The exported data was checked for correlation between independent variables and model fitness was checked using Hosmer-lemeshow model fitness test.

Descriptive statistics was done and the results were presented using texts and frequency tables. Binary logistic regression was done to assess the associations between dependent and independent variables (i.e. sociodemographic factors, health system related factors and environmental factors). Variables with p -value < 0.25 in the bivariate analysis were entered into multivariable logistic regression analysis model. Multivariable logistic regression was done to identify the predictors of malaria among under-five children and to control confounders. Statistical significance level was declared at $P < 0.05$.

Ethical considerations and consent for participants: Ethical clearance was obtained from Samara University, College of Health Science, Department of Public health. A written consent was sought from local authorities and concerned government officials after thoroughly discussing the ultimate purpose and method of the study. Finally, written informed consent was obtained from parents to involve their children in the study. We reassure that anyone who was not willing to participate in the study had full right to refuse and they can stop at any time if started to participate. Blood smears were taken by experienced laboratory technicians under aseptic technique using sterile gloves and disposable sterile lancets. Codes were used to ensure confidentiality of

Laboratory results. All cases with history of fever in the preceding three days and/or those who had fever on examination were offered antimalarial treatment as per the national protocol.

RESULTS

Socio-demographic characters of participants: A total of 484 participants were involved in this study with response rate of 97.7%. The mean age of the children was 28 months \pm 6.01 SD. Of the total participants, 68.0% resided in rural areas, more than half (59.5%) of the children's mothers were illiterate, 83.5% of the mothers were married, 76% of the parents were Muslims and nearly half (42%) of the mothers were housewives. The mean family size was 3.98 \pm 1.43SD (Table 1).

Health service and environmental related factors: Of the total participants, 12% did not have access to the nearby health facilities, 74.2% lived around stagnant and open water source environments; 48.6% of the participants said that there is manmade dam around their residency and 26.5% of the participants were living within five KMs of the nearby dam. The majority (81.8%) of the study participants lived in mud-roof houses (Table 2).

Table 1: Sociodemographic characteristics of participants in Dubti District, Afar Region, Northeast Ethiopia, 2018.

Predictor variables	Number (%)
Age of mother (in Years)	
15-24	60 (12.4)
25-34	249 (51.4)
\geq 35	175 (36.2)
Age of the child (in months)	
<12	32 (6.6)
12-23	176 (36.4)
24-35	97 (20.0)
36-47	86 (17.8)
48-59	93 (19.2)
Sex of the child	
Male	274 (56.6)
Female	210 (43.4)
Residence	
Rural	329 (68.0)
Urban	155 (32.0)
Education level of mothers	
Literate	196 (40.5)
Illiterate	288 (59.5)
Marital status	
Single	54 (11.2)
Married	404 (83.5)
Divorced	11 (2.3)
Widowed	15 (3.1)
Religion	
Orthodox	111 (22.9)
Muslim	368 (76.0)
Others+	5 (1.0)
Main occupation of the head HH	
Housewife	204 (42.1)
Farmer	51 (10.5)
Merchant	78 (16.1)
Government employed	130 (26.9)
Other++	21 (4.4)

Key: "Others+" = Protestant and catholic, "Others++" = daily labor, student, NGO employed

Table 2: Health service, housing conditions and environmental related factors of malaria among

under-five children in Dubti District, Northeast Ethiopia, 2018.

List of variables	Number (%)
Distance from health facilities	
< 5 KM	125 (25.8)
5-10 KM	169 (34.9)
>10 KM	57 (11.8)
Don't know exactly	133 (27.5)
Open and stagnant water around residency	
Yes	359 (74.2)
No	125 (25.8)
Natural or manmade dam around residency	
Yes	235 (48.6)
No	249 (51.4)
Distance from the dam	
< 5 Km	128 (26.5)
>= 5Km	262 (54.1)
Don't know	94 (19.4)
Roof of House	
Thatch	31 (6.4)
Corrugated iron sheet	57 (11.8)
Mud	396 (81.8)
Wall of the house	
Cement	13 (2.7)
Wood	387 (80.0)
Mud	84 (17.4)
Number of Windows	
Only one	50 (10.3)
Two	268 (55.4)
Three and above	166 (34.3)

Malaria prevalence, ITN ownership and utilization related factors: The overall prevalence of malaria infection among under-five children was 64% (95% CI 59.5% - 68.4%). More than half (66.5%) and one-fifth (22.2%) of the cases were caused by plasmodium falciparum and plasmodium vivax respectively. Of the total participants, only below half (40.9%) had bed nets for their households (Table 3).

Table 3: Malaria infection, ITN ownership and utilization among households of under-five

children in Dubti District, Northeast Ethiopia, 2018.

List of variables	Number (%)
Family size of the Household	
< 4	202 (41.7)
>= 4	282 (58.3)
Number of U5 children	
< 2	339 (70.0)
>= 2	145 (30.0)
Bed net available for households	
Yes	198 (40.9)
No	284 (59.1)
ITN utilization (morning Observation)	
Yes	161 (81.3)
No	37 (18.7)
Who uses the available ITN? (n=198)	
Mothers and children only	43 (21.7)
Mothers and fathers only	101 (50.9)
Whole family	54 (27.4)
Know methods to prevent Malaria infection	
Yes	444 (91.7)
No	40 (8.3)
Methods of malaria protection	
Sleeping under bed net	66 (13.6)
Wearing long sleeve clothes	247 (51.0)
Spray chemical to houses	109 (22.5)
Others+	62 (12.8)
Laboratory finding of the child (n=310)	
P.Falciparum	206 (66.5)
P.Vivax	72 (23.2)
Mixed infection	32 (10.3)
Confirmed malaria infection	
Negative	174 (36.0)
Positive	310 (64.0)

Key: Others+- use local materials, use different ointments to the exposed body part and use prophylaxis drugs

Factors associated with malaria among febrile children: After adjustment was made for covariates, children who lived in rural areas had 2 times higher risk of malaria infection compared to those who lived in urban areas [AOR=1.77: 95% CI 1.10-2.85]. The risk of malaria infection increased as the age of children increased [AOR=2.98: 95% CI 1.41-6.32]. Malaria infection was 2-folds higher among female children compared to male children [AOR=1.99: 95% CI 1.29-3.08]. Children whose mothers were literate had 59.4% less risk of malaria compared to those who had illiterate

mothers [AOR=0.406: 95% CI 0.26-0.63]. The risk of malaria infection was 9-folds higher among under-five children who did not sleep under Insecticide Treated Bed Net (ITN) at night compared to those who slept under ITN [AOR=9.10: 95% CI 1.01- 82.58]. Moreover, the likelihood ratio of malaria infection among under-five children who were living with family members infected with malaria in the last one month was 3-folds higher compared to those who had no family history of malaria infection [AOR=2.78: 95% CI 1.73, 4.45] (Table 4).

Table 4: Factors associated with malaria infection among under-five children in Dubti District, Northeast Ethiopia, 2018.

List of variable	Malaria status		COR (95% CI)	AOR (95% CI)
	Positive N(%)	Negative N(%)		
Residence				
Urban	197(59.9)	132(40.1)	1.00	1.00
Rural	113(72.9)	42 (27.1)	1.80(1.18,2.73)	1.77 (1.10,2.85)*
Sex of the child				
Female	163(59.5)	111(40.5)	1.58(1.08,2.32)	1.99(1.29,3.08)**
Male	147 (70.0)	63 (30.0)	1.00	1.00
Age of child (in Months)				
<12	17 (53.1)	15 (46.9)	0.59 (0.263, 1.34)	1.08 (0.44, 2.64)
12-23	104 (59.1)	72 (40.9)	0.75 (0.45, 1.27)	0.901(0.502, 1.62)
24-35	57 (58.8)	40 (41.2)	0.74 (0.41, 1.34)	0.72 (0.383, 1.35)
36-47	71 (82.6)	15 (17.4)	2.48 (1.23, 5.01)	2.98 (1.41, 6.32)**
48-59	61 (65.6)	32 (34.4)	1.00	1.00
Education level of the mother				
Illiterate	142(72.4)	54 (27.6)	1.00	1.00
Literate	168(58.3)	120(41.7)	0.532(0.36, 0.787)	0.406(0.26,0.63)***
ITN utilization (morning observation)				
Yes	89 (55.3)	72 (44.7)	1.00	1.00
No	221 (68.4)	102 (31.6)	1.75 (1.18, 2.58)	9.10 (1.01, 82.58)*
Number of ITN for family				
Zero	219 (67.6)	105 (32.4)	2.28 (1.21, 4.31)	2.23 (1.01, 4.89)*
1-2	70 (60.3)	46 (39.7)	1.66 (0.83, 3.35)	0.35 (0.038, 3.25)
>= 3	21 (47.7)	23 (52.3)	1.00	1.00
Family size (including extended families)				
< 4	118 (58.4)	84 (41.6)	1.00	1.00
>= 4	192 (68.1)	90 (31.9)	1.52 (1.04, 2.21)	1.52 (1.04, 2.21)
malaria infection among family In the last one months				
Yes	256 (69.0)	115 (31.0)	2.43 (1.58, 3.74)	2.78 (1.73, 4.45)***
No	54 (47.8)	59 (52.2)	1.00	1.00
Present of stagnant water around				
Yes	245 (68.2)	114 (31.8)	1.98 (1.31, 3.01)	1.98 (1.31, 3.01)
No	65 (52.0)	60 (48.0)	1.00	1.00
Distance from dam				
< 5Km	86 (67.2)	42 (32.8)	1.72 (0.99, 2.98)	1.72 (0.99, 2.98)
>= 5Km	224 (62.9)	132 (37.1)	1.00	1.00
Distance from the nearby health facilities				
<5Km	69 (55.2)	56 (44.8)	1.00	1.00
5-10Km	108 (63.9)	61 (36.1)	1.43 (0.89, 2.30)	1.43 (0.89, 2.30)
> 10Km	133 (70.0)	57 (30.0)	2.08 (1.05, 4.09)	2.08 (1.05, 4.09)

Key: COR= Crude Odds Ratio, AOR= Adjusted Odds Ratio, *= P<0.05, **=P<0.01, ***=P<0.001

DISCUSSION

Institution based cross sectional study design was employed to assess the prevalence and associated factors of malaria among febrile under-five children. The overall prevalence of malaria infection among under-five children was comparable to the general population. After adjusting for covariates, residence, education level of head of household, age of child, sex of child, ITN utilization, number of ITN available and history of malaria infection among family members in the last one month were the main predictors of malaria among febrile under-five children.

The overall prevalence of malaria infection among under-five children was 64% which is higher than a study done in BennaTsemay District, Southern Ethiopia (6.1 %) (17), a study conducted in Eritrea (2.2%) (25), a study done in Jigjiga, Ethiopia (2.8%) (15), a study done in Dilla District, Ethiopia (16%) (18), a study done in East Shewa Zone of Oromia Region, Ethiopia (25%) (5), a study done in East Shewa Zone of Oromia, Ethiopia (20.5%) (4), a study done in Zambia (54.3%) (26), and a study done in Djibouti (6.9%) (27). However, the prevalence in this study is lower than the study done in sub-Saharan African countries (64.5 %) (28), a study done in Burkina Faso (68%) (29) and a study done in Tanzania (78.91%)(30). The difference could be justified by the fact that the present study was conducted in the lowest altitude of Ethiopia which is malaria endemic compared to the settings of the previous study settings. There might be cut-point of children's age differences, sociocultural discrepancy and topographic differences between study settings.

Children who lived in rural areas had two times higher risk of malaria infection compared to those who lived in urban settings. This finding is in line with a study done in East Shewa Zone of Oromia Region (5), a study done in Burkina Faso (29) and a study done in Tanzania (30). This might be explained by the fact that children living in the rural community do not have access to available malaria protective methods including ITN use during night time and they do not have

access to other housing and clothing methods. Moreover, children in rural community spend more time outdoor compared to children in the urban community. Because of these reasons, they are more at risk for malaria infection.

This study revealed that as the age of children increased, risk of malaria infection increased by three folds. This finding is in line with a study done in Malawi (31) and a study conducted in Uganda to assess the risk factors associated with malaria infection among under-five children (19), a study done in Zambia [45] and a study done in Awassa District, Ethiopia (32). This could be justified by this is the immediate time (4-5 years of age), in which children participate to look after the cattle. Therefore, as the age of the children increases, they may stay out-door by looking after the cattle, in which they can be more prone for malaria infection.

Malaria infection among female children was 2 times higher compared to male children. However, this finding is not supported by the study done in Gilgel Gibe Health and Demographic surveillance system, Ethiopia (33). Although males are more prone to malaria because of their outdoor spending in Ethiopia, the discrepancy could be explained by the existence of gender-based discrimination practice in pastoral rural community, such as unequal food and other care provision which lead to impaired immunity of the children.

The likelihood of malaria infection among children who had educated mothers was less likely by 59.4% compared to those who had illiterate parents. This is in line with the study conducted in Uganda to assess the risk factors associated with malaria infection among under-five children (19), a study done in Madagascar (34) and a study done in Malawi (35). This could be justified by increased awareness of the mothers to proper use of the available ITN during sleeping which in turn increases the protection of malaria among children and the whole family, too. Moreover, when the education level of mothers increases, their knowledge about the available health services and feeding practice will also increase. Because of these reasons, children who had educated mothers had less risk of malaria infection.

Sleeping under insecticide treated bed net at night is the main stay of protection mechanism from malaria infection in lowland areas. This study revealed that under-five children who were not sleeping under ITN had nine-fold higher risk of malaria infection compared to those who were sleeping under ITN. This finding is supported by a study done in Jimma Town, Southwest Ethiopia (36), a study done in Malawi (31), and a community based RCT study done in Southern Ethiopia (37). The presence of active malaria infection among family members or neighborhoods can create the opportunity of infecting the apparently healthy under five children. Therefore, children and other family members should sleep under ITN at night to halt the transmission of malaria.

In this study, under-five children who were among households who did not have any ITN for the family members were two times more likely to be have malaria infection compared to those who had ITN for their families. This finding is similar with a study done in Northeast Ethiopia (4), a study done in Dilla District, Ethiopia (18), a study done in Oromia Region (5), and a study done to assess the malaria related factors among under-five children in rural Ethiopia (38). This could be explained by the fact that children from households who did not have bed nets are at high risk for malaria compared to those have have bed nets.

The presence of malaria infection among family members or around them can be used as good opportunity to infect under-five children and other apparently healthy family members. In this study, the likelihood of malaria infection among under-five children who had family members infected with malaria in the last one month was three-folds higher compared to those who had no family history of malaria infection. This might be justified by the fact that children from family members infected by malaria are more likely to be infected by malaria. This is because of the mosquito had access to feed on infected blood and transmitted the malaria to apparently healthy children living with infected family members. However, distance from health facilities, living around stagnant water and family size were not

significantly associated with malaria infection, after adjustment was made for selected covariates.

Although morning observational checklist was used to observe usage of the available bed nets, the study was not supplemented with qualitative methods to explore the possible barriers which hindered households' use of available bed nets at night time. Moreover, the study shares the limitations of cross sectional study designs.

In conclusion, this study revealed that the overall prevalence of malaria among under-five children was higher than the regional health bureau reports. Therefore, the findings of this study can help the region to intensively work on the distribution of ITN and other malaria prevention and control modalities to eliminate burden of malaria among under-five children.

In addition, healthcare providers should provide effective treatment for newly malaria infected patients to halt the transmission. Health education should be given for the community about proper utilization of the available bed nets to alter the transmission of malaria.

The district should supply adequate ITNs for the community. It should monitor the proper utilization of the distributed bed nets in the community. Additional longitudinal studies are recommended.

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