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Predictors of childhood malaria morbidity in insecticide treated bed net available households: A case control study in Shashego district, Southern Ethiopia.

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Abstract

Background: To date malaria prevention mainly focuses on reduction of human and mosquito contact through insecticide treated bed net. In spite of 100% bed net coverage and marked reduction in malaria mortality in southern region of Ethiopia, malaria is still the leading cause of under-five morbidity. The aim of this study was to identify predictors of malaria among under-five children living in households having insecticide treated bed net.

Methods: A community based case control study was conducted in Shashego district, Hadiya zone, Southern Ethiopia. Cases were under five children diagnosed with malaria, and controls were healthy under five children. A total of 310 under-five children paired with their mothers/care taker were selected from the community. Malaria status was determined using rapid diagnostic test. Structured questionnaire and anthropometric measurements were employed to collect data. Bivariate and multivariable logistic regression analysis was performed using SPSS version 20 software. P-value<0.05 and 95% CI was used to declare significant association.

Results: Nearly seven among ten 44 (69.8%) cases had *Plasmodium vivax* malaria. Three in five (60%) cases and controls used insecticide treated nets regularly. Having rectangular bed net (AOR=11.89, 95% CI: 5.57, 25.37), low wealth index quintile (AOR=3.21, 95% CI: 1.31, 7.86), household surrounded with maize/enset plant (AOR 5.89, 95% CI: 2.16, 13.98), moderate (AOR=13.23, 95% CI: 2.41, 72.54) and severe stunting (AOR=8.29, 95% CI: 1.80, 38.19) were independent predictors of malaria.

Conclusion: Prior to bed net distribution, the local community bed net shape preference should be considered for effective utilization and to reduce malaria cases. The finding also indicates poverty alleviation and reduction of chronic malnutrition plays significant role to avert malaria morbidity. Presence of enset plant around households and malaria risk needs further investigation.

Keywords: Malaria, Insecticide treated net, Under five children.

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Background

Globally, an estimated 212 million cases of malaria occurred in 2015, 90% of the cases were in the WHO African Region and 57.8% (114 million) malaria cases were reported from Sub-Saharan Africa. In 2015, 303 000 malaria deaths were estimated to have occurred among under-five, accounting for 70% of the global total [1]. In Ethiopia, more than 2.3 million malaria morbidity were reported between 2013 and 2014. Of these, 13.8% were occurred in under-five children [2].

To prevent malaria morbidity and mortality, the Ethiopia national malaria control strategy targeted to reduce malaria incidence by 40% from baseline of 2015 and to achieve near zero malaria deaths by 2020 [3]. In these respect, the country has made significant progress in prevention and reduction of malaria related mortality. In spite of 100% bed net coverage and marked reduction of malaria mortality in Southern Nation Nationalities and People Regional State (SNNPRS) of Ethiopia, malaria is still the leading cause of under-five morbidity [4]. According to the 2015 malaria indicator survey, the prevalence of fever among under five children was 22.3% in the region [5].

Studies revealed that use of Long Lasting Insecticide Treated Net (LLITN), indoor spraying of insecticide, high wealth index and educated care takers are associated with reduced malaria risk [6-8]. However, results on the relationship between bed net utilization, increased wealth index, and malaria risk are inconsistent across Sub-Saharan Africa countries [9,10]. On the other hand, study from Gambia, Uganda, Nigeria and Ethiopia [8] showed increased risk of malaria among children with stunting, severe acute malnutrition and sever wasting [11-13]. In contrary, study from Papua New Guinea revealed negative association between height for age Z-score (HAZ) and risk of malaria [14]. The association between stunting and malaria were far from complete.

Evidence based integrated approach is required to achieve targets of malaria reduction in Ethiopia. However, predictors of childhood malaria including Insecticide Treated Net (ITN) shape preferences, environmental factors other than swampy area, and socioeconomic related factors are not well studied in malaria risk areas of Southern Ethiopia. Despite, vulnerability and major consequences of malaria illness among under five, most studies were conducted among adult population of the country [7]. Therefore, this study aimed to identify predictors of malaria among under five children living in households having insecticide treated bed net in the rural community of Shashego district, Southern Ethiopia.

Methods and Materials

Study Design and Setting

A community based case-control study design was used to identify predictors of malaria among under five children. We compared under five children having malaria with healthy children. Children were recruited from rural community of Shashego district, Hadiya zone, Southern Ethiopia from May to August, 2015. Astronomically, the district is located at 7°41'-7°70'N latitude and 37°92-38°12'E longitude. Altitude ranges from 1501-2500 m above sea level. It is found in intermediate highlands (between 1,500 and 3,148 m above sea level). The mean annual rainfall range from 1001 to 1200 mm. The yearly mean temperature varied from 17.6°C to 20.36°C over the years. The district has a total population of 95,503. Of these, males consisting of 47,899 and females 47,604 with a very high proportion of population in the young age group [15].

Participants and Study Size

The study populations were selected cases and controls of under five children living in ITN available households. Cases were under five children with sign and symptoms of malaria and positive for malaria Rapid Diagnostic Test (RDT). Controls were under-five children without sign and symptoms of malaria and negative for malaria RDT and living in the same *kebele* with cases (*kebele is the smallest administrative unit in Ethiopia*). The sample size was calculated using Open Epi statistical software for unmatched case control design with the assumption of the proportion of exposure among control (P=0.43), 95% confidence interval, 80% power, odds ratio of 2.31 and case to control ratio of 1:4 [16]. The calculated sample size yields 315 subjects (i.e., 63 cases and 252 controls). From the total 34 rural *kebeles* in the district, 8 *kebeles* were selected using simple random sampling technique. Number of households having children age 1-59 months (4477 children) was obtained from health extension workers. Probability proportional to size method was used to allocate the sample size to each selected *kebeles*. After cases identification, controls were selected from the same *kebele* with the cases. Controls with prior malaria diagnosis in the preceding one year, sign and symptoms of malaria during the study period, and primary residence outside the study area were excluded.

Data Collection Instrument and Procedure

Pre-tested and interviewer-administered structured questionnaire and malaria RDT were used to collect data. The questionnaire was initially prepared in English and then translated to Amharic. Then the Amharic questionnaire was back translated to English to check for any inconsistency in the meaning of the words and/or concepts. The questionnaire contains five parts. The first part comprised laboratory test for malaria. The second part includes socio-demographic and economic variables. The third part contains ITN utilization and related factors. The fourth part encompasses housing structure and condition characteristics. The fifth part includes anthropometric measurements. A total of eight nurses and two supervisors were involved in the data collection. Before data collection two days training was given for data collectors and supervisors. The training was given by focusing on contents of the questionnaire, malaria RDT procedure, and process of data collection. Blood samples were collected by taking finger pricking from both cases and controls [17]. Multi-species RDT kit was used to diagnose malaria according to standard procedure recommended by manufacturers [18]. Height for children aged 25-59 months were measured using a measuring tape in a standing position. For children aged 6-24 months length was measured using calibrated portable board [19]. Both measurements were recorded in centimeter (cm). The data collection process was supervised through observation and the filled questionnaires were checked for consistency and completeness.

Measurement

Malaria status was the main outcome variable. Under five children with sign and symptom of malaria and positive for malaria RDT were considered as malaria cases. Controls were under five children without sign and symptom of malaria and negative for malaria RDT.

Reliability test was performed using variables involved in measuring the wealth of the households. Cronbach's alpha was calculated for household and asset variables. Then variables selected based on computed alpha values were entered in to the principal component analysis to estimate a relative household wealth index. Tercile of the wealth index was generated and used to classify households as low, middle and high wealth indexes.

Children whose height-for-age Z-scores are below minus two standard deviations (-2 SD) and -3 SD from the median of the WHO reference population were categorized as stunted and severely stunted [19].

Data Processing and Analysis

After data collection, each questionnaire was checked for completeness and the data were entered in to Epi info version 3.5.1 statistical software. Anthropometric data were entered in WHO anthro software version 3.2.2 to calculate Z-scores height for age data. Then these Z- scores were exported to SPSS version 20 statistical software and merged with other variables for further analysis. Variables with p-value of <0.20 in bivariate analysis were selected for multivariate analysis. Multivariable logistic regression analysis was done to control the effect of confounders. In the final model, variables with Variance Inflation Factor (VIF) less than 10% were included to avoid multi-collinearity. P-value less than 0.05 were used as cut of point to determine presence of statistical significance. Goodness of fit for the final model was assessed using Hosmer and Lemeshow test.

Results

Socio-Demographic, Economic and Clinical Characteristics

A total of 310 participants (63 cases and 247 controls) were included in the study with response rate of 98%. Of the total study participants, female accounted for 161 (51.3%) and malaria cases were nearly equally distributed between male 30 (47.6%) and female 33 (52.4%). Nearly seven among ten, 44 (69.8%) cases were infected by *P. vivax*, followed by *P. falciparum* 13 (20.6%), and mixed infection 6 (9.5%). The mean (± standard deviation) of the children's age was 26.06 (± 13.84) months. Nearly three in five, 36 (57.1%) of cases were age between 6-24 months. Majority, 33 (54.1%) mothers of cases and 129 (51.2%) mothers of controls did not attend formal education. Overall, 103 (32.8%), 106 (33.8%) and 105 (33.4%) of mothers were in low, medium and high wealth index respectively (Table 1).

Predictors of Childhood Malaria

After controlling for frequency of bed net use, presence of hole, and nets re-treatments in the multivariate analysis, shape of ITN, presence of maize/*enset* plant, wealth index, and presence of stunting were identified as independent predictors of childhood malaria.

Children living in a household having rectangular ITN were 11.89 times more likely to have malaria compared with children living in a household having conical shape ITN (AOR=11.89, 95% CI: 5.57, 25.37).

The study showed that children living in houses surrounded with maize/*enset* plant in their compound were 5.49 times more likely to be infected by malaria than children living in houses with no maize/*enset* plant inside the compound (AOR 5.49, 95% CI: 2.16, 13.98).

On the other hand, children living in low wealth index households were 3.21 times more likely to have malaria when compared with children living in high wealth index households (AOR=3.21, 95% CI: 1.31, 7.86).

Another important predictor was the presence of stunting among children. Compared to children with normal HAZ score, the probability of having malaria was increased by 13.23 (AOR=13.23, 95% CI: 2.41, 72.54) among stunted and 8.29 times among severely stunted children (Table 2).

Discussion

In this study, we identified four predictors that affected the risk of under-five malaria in Shashego district, Southern Ethiopia. These predictors were; shape of ITN, presence of maize/*enset* plant within the surrounding compound of their household, household wealth index, and stunted child growth. These findings provide information for program managers to design intervention that improves ITN utilization. Furthermore, this study informs policy makers on the role of sustainable poverty alleviation and nutritional intervention to achieve malaria related SDG target.

The increased risk of malaria occurrence among children living in a household having rectangular shape ITN compared to household having conical ITN. This could be explained by the need for additional materials to tuck

Table 1. *Socio-demographic and economic characteristics of the participants in Shashego district, Hadiya zone, southern Ethiopia*

Variables	Case N (%)	Control N (%)	Total N (%)
Age of the child			
<6	6 (9.5)	8 (3.2)	14 (4.5)
6-24	36 (57.1)	122 (49.4)	158 (51.0)
24-60	21 (33.3)	117 (47.4)	138 (44.5)
Sex of the child			
Female	33 (52.4)	125 (50.6)	158 (51.0)
Male	30 (47.6)	122 (49.4)	152 (49.0)
Religion			
Protestant	31 (49.2)	124 (50.2)	155 (50.0)
Orthodox	3 (4.8)	22 (8.9)	25 (8.1)
Muslim	29 (46.0)	101 (40.9)	130 (41.9)
Ethnicity			
Hadiya	57 (90.5)	234 (94.7)	291 (93.9)
Silte	6 (9.5)	13 (5.3)	19 (6.1)
Educational status of mother			
No education	34 (54.0)	129 (52.2)	163 (52.6)
Read and write	12 (19.0)	34 (13.8)	46 (14.8)
Primary	9 (14.3)	73 (29.6)	82 (26.5)
Secondary	8 (12.7)	11 (4.5)	19 (6.1)
Educational status of father			
No education	33 (52.4)	126 (51.0)	159 (51.3)
Read and write	9 (14.3)	47 (19.0)	56 (18.1)
Primary	17 (27.0)	64 (25.9)	56 (18.1)
Secondary	4 (6.3)	10 (4.0)	14 (4.5)
Occupation status of mother			
House wife	61 (96.8)	226 (91.5)	287 (92.7)
Government/NGO employee	2 (3.2)	21 (8.5)	23 (7.4)
Occupation status of father			
Farmer	44 (69.8)	190 (76.9)	234 (75.5)
Government/NGO employee	1 (1.6)	2 (0.8)	3 (1.0)
Merchant	18 (28.6)	55 (22.3)	73 (23.5)
Marital status			
Single	3 (4.8)	3 (1.2)	6 (1.9)
Married	57 (90.5)	241 (97.6)	298 (96.1)
Divorced	3 (4.8)	3 (1.2)	6 (1.9)
Type of marriage			
Polygamy	18 (28.6)	20 (8.1)	38 (12.3)
Monogamy	45 (71.4)	227 (91.9)	272 (87.7)
Wealth index			
Low	27 (42.9)	75 (30.4)	102 (32.9)
Medium	23 (36.5)	80 (32.4)	103 (33.2)
High	13 (20.6)	92 (37.2)	105 (33.9)

rectangular ITN. In our study, most of the participants had no bed and sleep on floor (95%).

Findings on bed net use and malaria occurrence among under five children were inconsistent across African countries. Our finding was in congruent with the study conducted in Nigeria where no association between bed net use and fever prevalence among under five children [20]. Negative association was reported by another study conducted in Nigeria [21]. However, the relationship was positive in Ghana, Kenya and Sierra Leone [9]. The difference might be due to malaria diagnosis method, and study design. Despite the fact that malaria is not the only Acute Febrile Illness (AFI), fever was used as a method of malaria diagnosis in the other studies. For the other studies in Ghana, Kenya, Sierra Leone and Nigeria, residual malaria transmission may be the reason for the positive relationship of bed net use and malaria.

Table 2. *Multivariable logistic regression model predicting factors associated with malaria among under five children in Shashego district, Hadiya zone, southern Ethiopia, 2015*

Predictors	Case N (%)	Control N (%)	COR, 95% CI	AOR, 95% CI
Shape of bed net				
Conical	19 (6.1)	211 (68.1)	1	1
Rectangular	44 (14.2)	36 (11.6)	13.21 (6.95, 25.08)	11.89 (5.57, 25.37) *
Frequency of using the nets				
Regularly	10 (52.6)	176 (83.4)	1	1
Intermittently	9 (47.4)	35 (16.6)	4.53 (1.71, 11.95)	1.87 (0.49, 6.99)
Re-treated with an insecticide				
Yes	15 (23.8)	48 (76.2)	1	1
No	48 (76.2)	88 (35.6)	5.78 (3.06, 10.92)	1.5 (0.48, 4.69)
Hole on the nets				
Yes	9 (14.3)	18 (7.3)	1	1
No	9 (14.3)	229 (92.7)	0.47 (0.20, 1.12)	1.02 (0.34, 2.89)
Maize/Enset plant around				
Yes	22 (7.0)	15 (4.8)	8.44 (4.05, 17.61)	5.49 (2.16, 13.98) *
No	41 (13.1)	236 (75.2)	1	1
Wealth index				
Low	27 (8.6)	76 (24.2)	2.51 (1.21, 5.21)	3.21 (1.31, 7.86)*
Medium	23 (7.3)	83 (26.4)	1.96 (0.93, 4.12)	0.85 (0.32, 2.25)
High	13 (4.1)	92 (29.3)	1	1
HAZ				
Normal	2 (0.6)	81 (25.8)	1	1
Stunted	10 (3.2)	31 (9.9)	13.07 (2.71, 63.02)	13.23 (2.41, 72.54) *
Severe stunt	51 (16.2)	31 (9.9)	14.86 (3.52, 62.66)	8.29 (1.80, 38.19) *

* P-value<0.05

The study revealed that children living in household compounds surrounded with maize and/or enset plant (False banana) were more prone for malaria infection than children living in household where there no maize/enset around. This might be due to the nature of maize plants to form favorable environment for enhanced Anopheles breeding. Evidence indicates that pollen from maize or sweet corn is known to be an important food source for the larvae of *Anopheles arabiensis* and consequently cultivation of the crop can increase malaria transmission in endemic areas [22]. The relationship between enset plant and risk of malaria could be due to the capacity of enset plant to store water in the space between stem and leafs that may serve as mosquito larvae breeding site.

Poor people are at increased risk of frequent malaria infection [23]. The result of this study shows negative relation between household wealth index and malaria. Children living in households with low wealth index were at increased risk for malaria than those in households with high wealth index. Similar result reported by the study conducted in Ghana, in which, relative to lowest wealth index quintile, children in highest quintile were less likely to report fever [24]. This relationship is confirmed by other study conducted in Tanzania [10]. One reason that could account for this relationship is that wealthier households are better to provide preventive measures to household members including children under age five. This finding also implies poverty could be a major barrier for early and effective treatment seeking practice.

Our finding showed increased risk of malaria occurrence among children with stunting than children with normal HAZ score. This is in agreement with the study conducted in Gambia, and Kenya, in which stunting was reported as the risk factors of malaria [11,25]. This might be due to low immunity of under five children with stunting.

Limitation

This study is limited by the use of Rapid Diagnostic Test (RDT) for malaria diagnosis. However, RDT offer the potential to extend accurate malaria diagnosis to rural areas when microscopy services are not available; easy to perform the test and interpret the result. Non random selection of the cases may affect generalizability of the finding.

Conclusion

Before ITN distribution, the local community ITN shape preference should be assessed for effective utilization and to reduce malaria cases. Poverty alleviation along with long term nutritional intervention and food security has an effect to reduce malaria disease occurrence. We recommend further entomological study on presence of enset around households and malaria risk.

Declarations

Ethical Approval and Consent to Participate

The study obtained ethical clearance from Ethical and Research Approval (ERA) Committee of Hossana College of Health Sciences. Permission paper was obtained from administration of Shashego district Health office. Written consent was obtained from each study participants care giver/family while their right to refuse were respected. Identification of study participants by name were avoided to assure the confidentiality of the information obtained. Children diagnosed with malaria were referred to the nearby health facilities for treatment.

Author Contribution

DJ conceived the study and was involved in the design, coordination, field supervision, data analysis and drafted the manuscript. EA, TG and TM participated in the design, field supervision, and report writing. DTs, TA, KH, FB, AA, HG and MA were participated in the design, data analysis, manuscript preparation and provided critical feedback on the method and result. All authors read and approved the manuscript.

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Hossana College of Health Sciences gave ethical clearance and support for the study, but has no role in the design, data collection, analysis, report writing and decision on manuscript submission. The authors appreciate the study participants care givers for their cooperation in providing the necessary information. We acknowledge Hadiya zone health department, the district health office and the community for their strong support during the study.

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