Malaria Outbreak Investigation and Response in Bolosso Sore Wereda, Welayta Zone, SNNPR, Ethiopia, 2019

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Abstract

Background; Malaria is caused by one or more of the five species of plasmodium species that can infect by the bite of female Anopheles. In Ethiopia, about 68% of the total population resides in areas with high malaria risk and 2,174,707 cases and 662 deaths due to malaria were reported in 2014–2015 with case fatality rate of 0.03%. The outbreak was reported on April 22/2019 (WHO week 17) then we investigate the outbreak to describe the magnitude of morbidity and mortality due to malaria outbreak, identify the etiologic agent and investigate factors associated with an occurrence of malaria outbreak.

Methods; we conducted case control study in Bolosso Sore woreda. We used outbreak investigation questionnaire to assess risk factor for both cases and controls of patients. We collected 75 cases and 150 controls by face to face interview by administered questionnaire. We analysed the data with Epi Info.Version7.2.0.1 and SPSS.V 23 and the statistical we used 95% CI.

Result; the overall attack rate of the woreda was 36.4 per 1000. From the cases Males are slightly more affected than females (38: 37) .The most affected age group is >15 years, 54 (72%) followed by 5-14, 17(22.7%). Plasmodium falcifarem is the highest proportion of malaria in the wereda. Having impregnated treated net have no problem but impregnated treated net who have used sometimes (AOR 10.214; 95% CI) was identified as a risk factor for malaria or more likely affected by malaria ten times each respectively than those impregnated treated net used always.

Conclusion; Presence of intermittent rivers nearest to the community, open deep well near to their home and usage of impregnated treated net (those impregnated treated net use sometimes and never use impregnated treated net) were risk factors for onset/occurrence of the outbreak of malaria. We recommend all malarias area insecticide treated bed net should be distributed for all households according to their family member. Beside this, utilization of bed net should be monitored and optimized.

Background

Malaria is caused by one or more of the five species of plasmodium species that can infect by the bite of female Anopheles [1]. Humans are infected by malaria through the bite of a female Anopheles mosquito. Once in the human body the parasites multiply rapidly, first in the liver, followed in the blood.

Globally, malaria affects the lives of 247 million people and kills close to a million each year 90% of which are among Africans [2]. Approximately 53 million Ethiopians (63% of the population) live in malaria risk areas. Of these, 33 million almost 40 % of the total population are in endemic areas, and nearly one quarter of Ethiopians reside in endemic prone areas. Ethiopia is among the few countries with unstable malaria transmission and also is one of the most malaria epidemic-prone countries in Africa.

Due to Ethiopia's complex topography and seasonal rainfall support largely seasonal short-term transmission, malaria is generally unstable that put the population non-immune [3]. Recurrent outbreaks and epidemics are associated with cyclical climatic variations that lead to increased vector survival in the

country. Generally, malaria cases are peaked after two rainy season (March – May and July-September). The country has experienced the worst malaria epidemics in 1958 with three million cases and 150,000 deaths [4].

Other triggering factors like unusual local weather phenomena and activities resulting in environmental modification that increase vector population, increased vulnerability of population from famine and malnutrition, Interruptions of anti-malarial measures which have kept malaria under control. However, there could be outbreak in high transmission areas if there is deterioration of health system, interruption of anti-malarial measures or migration of non-immune individuals [5].

Malaria outbreak occurs within the first five years this is the highest one in the district. Moreover, prevention programs and timely investigation of outbreaks by using surveillance data are the main purposes of Integrated Disease Surveillance. The purpose of this study is to verify the existence of the outbreak, identify gaps and risk factors contributed to the existence of the outbreak and provide proper public health intervention for the outbreak in Bolosso Sore woreda.

Methodology

Study Area

Bolosso Sore is one of the woredas in the SNNPR of Ethiopia. Bolosso Sore located from the North and East latitude: 7°04'60.00"N longitude: 37° 39' 59.99" E respectively. It has 32 kebeles and 8 health centers. Some kebele of the wereda are high malarias i.e. 17 kebeles of the wereda are malarias area and the outbreak occur in all cluster but differ in magnitude. The climate and the topography of the area are favourable for malaria insect breeding.

Study design and Period

Conducted descriptive and unmatched case- control study for analytical part of the study on the active patients. And it conducted from April 22/2019-August 28/2019.

Source population and Study Subject

The source population are peoples living in Bolosso Sore woreda of Welayta Zone at risk of malaria. And the specific study subjects for cases were febrile patients who are positive for malaria parasites by the rapid diagnostic tests or microscope. Study subjects for control were non febrile apparently healthy person who is living in the same village with the active case patient from April 22-August 28/2019.

Sample size determination

The sample size was calculated based on power requirements at both cases and control. It is done by using two by two tables by adjusting two sided confidence level at 95%, power (percentage chance of detecting) was 80 %, ratio of control to case at 2, hypothetical proportion of controls with exposure at 50% and least extreme Odds Ratio to be detected was OR of 2.3 of Gemechu malaria outbreak

investigation (calculated from Epiinfo7.2.0.1) [6]. The total number of people included in the study were 225 individuals, 75 were cases and 150 were controls. And All Case subjects were active cases and controls were selected for each case in 1:2 ratio bases from the same Community family or neighbour from controls were at the same time.

Sampling procedure and Sampling Technique

Health centers were selected for cases- control study and community diagnosis based on the high weekly Malaria case report i.e. purposely. We used a structured and semi structured questionnaire to conduct interview from cases and controls on the risk factors. And also interviewed the health office and health cluster (HCs) PHEM officers on control and prevention program in the woreda. The sampling technique was those patients who came to the health center and became malaria positive and selected randomly from the list. That means we use simple random sampling technique.

Laboratory Method

Rapid Diagnostic Test and microscope were used in the health centre. Health extension workers also used RDT to identify confirmed malaria cases at health post and Community level during outbreak investigation case searching.

Environmental Assessment

Data was collected on the presence of potential mosquito breeding sites. Selected case-patients and controls were interviewed about presence of mosquito breeding sites in their compound and near to home. In addition, availability of uncovered plastic water container, old tires, stagnant water and broken glasses in the home or outside the home were also critically assessed.

Data Analysis

Quantitative data was collected using face to face interviewing by administered questionnaire that addressed socio-demographic characteristics, clinical manifestation, potential exposures (risk factor), review of weekly integrated disease surveillance and response at different level (Wereda Health office), visited of the affected village and interview community members. We entered data by using Epi Info version 7.2.0.1 and we use SPSS to analyse associated factors. The significance of risk factors for the outbreak was determined through logistic regression of bivariate and multivariate analysis by calculating Odds Ratio and 95% Confidence Interval. A p-value of less than 0.05 was considered significant.

Results

There was a total of 225 samples of a malaria cases and throughout the outbreak there were no death occur. From the total of malaria confirmed cases the most affected age group was > 15 years, 54 (72%) followed by 5–14, 17(22.7%). From the total 50% of them were > 15 years of age. Males 38 (51%) were slightly more affected than females. And nobody refused to be interviewed. The other socio demographic parts are expressed below.

Laboratory

From April 15 to August 25, 2019 a total of 4,380 blood smear positive (confirmed positive) of Bolosso Sore Woreda. Of which, 3,281 (75%) were positive for P. Falciparum, 1,100 (25%) were P. Vivax. This is from a weekly report of the zone and the wereda.

Descriptive Epidemiology

Description of the overall epidemic situation

Five years wereda data was shows that there was no outbreak within those five years. Bolosso Sore wereda Weekly malaria case passed the threshold level on WHO Week 18 (from April 22) and the health office has detected the outbreak on Week 18 based on the established threshold and writing letters about the outbreak to health centers for alerting the outbreak then similarly to Zonal health department. And the wereda was actively worked for the response of the outbreak and they controlled it. There was no death reported. At wereda and Zonal level no investigation was done until the national team conduct investigation.

Description of cases by Time

The number of cases passed the threshold level in epi. Week of 18 /2019 continued consistently increasing and reached peak on week (20) and then with sharp decrease on each week and steadily decreasing from week 29 up to Week 35 and it was decreased and controlled. The outbreak started on Week 18 of the epidemiologic week by crossing the threshold and reached peak on week 20. The intervention was started lately by mass treatment and ten kebeles of focal points or areas Profoxer/IRS sprayed and stagnant water were larvicide by Abet chemical.

Epi curve of the Outbreak

The outbreak was started from week 18, peaks at week 20 and then stopped or controlled from week 34 till this investigation done.

Clinical features of cases

A total of 75 active cases from Gurmo kosha H/C cluster, Achura H/C cluster, Gara Gudo H/C cluster, Woybo H/C cluster, Legama H/C cluster, D/Salata H/C cluster and selected kebeles of each cluster of Bolosso Sore wereda enrolled in the study from the bigining of the outbreak April 2019 till week 35. This is only the cases that interviewed by questionnaire.

The most frequently manifested clinical feature among the cases were fever, shivering, vomiting, headache, Anorexia, rigor and back pain 73(97%), 51(68%), 48(64%), 70(93%), 60(80%), 58(77%) and 59(79%) respectively. There were complications or severe malaria happened according to the sign and symptoms they answered. Those were altered consciousness 1%, not able to fed or drunk 5%, severe dehydration 6 %, persistent fever 9%, frequent vomiting 7% and unable to sit or stand up 4%.

Description of Cases by person

Bolosso Sore Woreda has a total population under surveillance of 211,145 out of this 120,252 are at risk of malaria. The overall attack rate (AR) for the woreda was 36.4/1000. From the cases Males are more affected than females (38: 37) .The most affected age group is > 15 years, 54 (72%) followed by 5–14, 17(22.7%). The educational status of the study participants were illiterate (7) and 31 attended school at primary level. Regarding Marital status of study participants, 52% were married, 16% NA or underage and 32% single.

Description of cases by place

Most active cases were from Gurmo Koysha cluster. The wereda has 8 clusters in which in each cluster has three to five kebeles. Embecho and Afama Bancha clusters were not included in case controls study because of their topography difficulty and the number of cases somehow small. We interviewed 75 a case from six clusters (G/koysha H/C, Gara Gudo H/C, Achura H/C, D/salata H/C, Legama H/C and Woybo H/C). The investigation team treated a total of serologically confirmed (positive) 75 cases.

Analytical Epidemiology (Case -Control)

A total of 75 malaria cases and 150 apparently healthy controls were included into this analysis. We assessed possible risk factors that contribute to contracting malaria. In another bi-variate analysis who staying overnight 43% (P-value 0.028) is less likely affected by malaria than those not staying overnight. ITN who have used sometimes (COR 2.343) and those have ITN and they never use ITN (COR 2.248) were identified as a risk factor for malaria or more likely affected by malaria two times each respectively than those used ITN always.

In multi variate logistic regression some times and never ITN usage (AOR 10.214, 95 % CI1.163-89.725 and AOR 32.098, 95% CI 3.570-288.133 respectively) were found to be independent risk factors of malaria infection in the study area or they were the highest risk factors. In general, those who have an AOR < 1 they were found to be preventive or had less risk for malaria infection (Table 6).

Table 1
; Socio demographic Characteristics of Bolosso Sore Woreda, Wolayta zone, SNNPR,
September, 2019

SNO.	Variables		Case	Control	AR	Total	%
1	Occupation	Employed	2	23	3%	25	11%
		Unemployed	5	8	7%	13	6%
		Student	31	38	41%	69	30.7%
		Pastoralist	5	1	5%	6	2.7%
		Farmer	32	81	44%	113	50.2%
2	Total family Size	2–5 members	30	40	40%	70	31%
		> 5 members	46	109	61%	155	69%
3	Marital Status	Married	39	80	52%	119	53%
		Single	24	51	32%	75	33%
		NA	12	19	16%	31	14%
4	Education	Illiterate	7	24	9%	31	14%
		Primary	31	58	41%	89	40%
		Secondary	16	23	21%	39	17%
		Tertiary	4	11	5%	15	7%
		Non-formal	8	21	11%	29	13%
		NA	5	17	7%	22	10%

Table 2
; distributions of Total malaria positivity by age group and sex
in Bolosso Sore Wereda, Wolayta Zone, August 2019 (from the
interview of cases)

Characteristics	Catagory	Total Malaria	PF	PV
Sex	Male	38	35	3
	Female	37	27	10
	Total	75	62	13
Age	< 5 years	5	5	0
	5–14 years	17	15	2
	> 15 years	53	42	13

Table 3

Distribution of malaria cases by cluster and AR in Bolosso Sore Wereda, Wolayta zone, SNNRP, April 21 to August 25, 2019 (from WHO epi week 17–35)

SNO	Name of H/C	Total population	Number of PF	Number of PV	Total number of cases	AR per 1000
01	G/koysha H/C	23,225	785	257	1,042	45%
02	Gara gudo H/C	37,106	378	63	441	11.9%
03	Achura H/C	17,309	131	78	209	12%
04	Dangra Salata H/C	19,473	741	157	898	46.1%
05	Legama H/C	20,470	524	116	640	31.3%
06	Woybo H/C	25,381	111	41	152	6%
07	Embecho H/C	33,883	232	276	508	15%
08	Afama Bancha H/C	32,589	110	119	229	7%

Table 4
; Socio-demographic Bi-varate Analysis of Bolosso Sore Wereda, SNNPR, 2019

SNO	Variables		Case in %	control in %	95% CI		COR	P-value
					Lower	Upper		
1	Age group	< 5 years	5(6%)	18(12%)	1	1	1	1
		5– 14 y	17(23%)	37(25%)	0.192	1.9	0.605	0.389
		> 15	53(71%)	95(63%)	0.18	1.417	0.498	0.191
2	Occupation	Employee	2(2.7%)	23(15%)	1.024	20.656	4.600	0.046
		unemployed	5(6.7%)	8(5.3%)	0.195	2.104	0.640	0.462
		Student	31(41%)	38(25%)	0.262	0.918	0.490	0.026
		Pastoralist	5(7%)	1(0.7%)	0.009	0.712	0.080	0.024
		Farmer	33(44%)	80(54%)	1	1	1	1
3	Education	Illiterate	10(13%)	21(14%)	1	1	1	1
		Primary	31(41%)	58(39%)	0.373	2.127	0.891	0.795
		Secondary	17(23%)	22(15%)	0.23	1.648	0.616	0.335
		Teritiary	4(5%)	11(7%)	0.333	5.153	1.31	0.7
		Non formal	8(11%)	21(14%)	0.412	3.79	1.25	0.693
		NA	5(7%)	17(11%)	0.464	5.648	1.619	0.45

Table 5
; Risk factors Bi-varate Analysis of Bolosso Sore Wereda, SNNPR, 2019

1	Travel History	Yes	5(7%)	0	0	0	0	0.999
		No	70(93%)	150(100%)	1	1	1	1
2	Staying overnight	yes	32(43%)	42(28%)	0.293	0.933	0.523	0.028
		No	43(57%)	108(72%)	1	1	1	1
3	Having ITN	yes	70(93%)	129(86%)	0.159	1.214	0.439	0.113
		No	5(7%)	21(14%)	1	1	1	1
4	ITN Usage	Always	36(48%)	30(20%)	1	1	1	1
		Sometimes	34(45%)	99(66%)	1.240	4.425	2.343	0.009
		Never	5(7%)	21(14%)	1.007	5.021	2.248	0.048
5	Number of ITN	One	6(8%)	57(38%)	0.788	9.354	2.714	0.114
		2-3 ITN	53(71%)	70(47%)	0.142	1.000	0.377	0.050
		4-6 ITN	10(13%)	2(1%)	0.010	0.335	0.057	0.002
		Non have	6(8%)	21(14%)	0.164	1	1	1
6	IRS	Yes	35(47%)	28(19%)	0.242	0.844	0.452	0.013
		No	40(53%)	122(81%)	1	1	1	1
7	Open deep wel	Yes	39(52%)	57(38%)	1.009	3.095	1.768	0.046
		No	36(48%)	93(62%)	1	1	1	1
8	Broken glass	Yes	36(48%)	43(29%)	0.245	0.774	0.435	0.005
		No	39(52%)	107(71%)	1	1	1	1
9	Plastic container	Yes	61(81%)	59(39%)	0.109	0.411	0.212	0.00
		No	14(19%)	91(61%)	1	1	1	1
10	Gutter	Yes	24(32%)	42(28%)	0.453	1.509	0.826	0.535
		No	51(78%)	108(72%)	1	1	1	1
11	Stagnant water	Yes	58(77%)	88(59%)	0.221	0.782	0.416	0.006
		No	17(23%)	62(41%)	1	1	1	1
12	Intermittent River	Yes	41(55%)	61(41%)	1.032	3.162	1.806	0.038
		No	34(45%)	89(59%)	1	1	1	1
13	Tick grass	Yes	6(8%)	14(9%)	0.436	3.216	1.184	0.741

No	69(92%)	136(91%)	1	1	1	1
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Table 6

; Multivariate analysis of risk factors for malaria outbreak Bolosso Sore wereda, Wolayta zone, SNNPR, Ethiopia, 2019

SNO	Variables	Category			AOR	95 CI		P-Value
			Case in %	Control in %		Lower	Upper	
1	Occupation	Employee	2(2.7%)	23(15%)	1.832	0.318	10.537	0.498
		unemployed	5(6.7%)	8(5.3%)	0.079	0.013	0.501	0.007
		Student	31(41%)	38(25%)	0.187	0.070	0.515	0.001
		Pastoralist	5(7%)	1(0.7%)	0.027	0.001	0.535	0.018
		Farmer	33(44%)	80(54%)	1	1	1	1
2	Staying overnight	yes	32(43%)	42(28%)	0.372	0.149	0.930	0.034
		No	43(57%)	108(72)	1	1	1	1
3	ITN Usage	Never	36(48%)	30(20%)	32.098	3.570	288.633	0.002
		Sometimes	34(45%)	99(66%)	10.214	1.163	89.725	0.036
		Always	5(7%)	21(14%)	1	1	1	1
4	Number of ITN	One	6(8%)	57(38%)	0.112	0.010	1.217	0.072
		2–3 ITN	53(71%)	70(47%)	0.014	0.001	0.145	0.000
		4–6 ITN	10(13%)	2(1%)	0.002	0.000	0.044	0.000
		Non have	6(8%)	21(14%)	1	1	1	1
5	IRS	Yes	35(47%)	28(19%)	0.149	0.056	0.396	0.000
		No	40(53%)	122(81)	1	1	1	1
6	Open deep well	Yes	39(52%)	57(38%)	0.423	0.173	1.033	0.059
		No	36(48%)	93(62%)	1	1	1	1
7	Broken glass	Yes	36(48%)	43(29%)	0.193	0.074	0.506	0.001
		No	39(52%)	107(71)	1	1	1	1
8	Plastic container	Yes	61(81%)	59(39%)	0.134	0.050	0.361	0.000
		No	14(19%)	91(61%)	1	1	1	1
9	Intermittent river	Yes	41(55%)	61(41%)	0.166	0.065	0.425	0.000
		No	34(45%)	89(59%)	1	1	1	1

In addition to the above analysis in the study area not only in the study area in the whole country there were no repellents and there were no screening of houses for malaria.

Environmental Assessment

Observation was conducted for availability of stagnant water, building for fish breeding, broken glass, intermittent river near to the community and other potential mosquito breeding sites. In all assessed kebeles, it was identified that there was larvae of mosquitoes in observed stagnant water by naked eye.

Public health intervention

A Total of 10 kebeles were sprayed with profoxer chemical. Communities were mobilized and taught on prevention and control measures of malaria disease. Active case search and early management were done at community and health facility level. Larvicide was done those had stagnant water and larvae were seen by Abet chemical.

Discussion

In our study area male Populations were more affected (51%) than female (49%). this is might be due to the fact that males are usually engaged in outdoor activities such as protecting domestic animals and agriculture activities. This study was similar to Arbaminch zuria woreda, Gamogofa zone SNNPR (54.63%) [7] which is lower than Arbamich Zuria wereda. But higher than the Indian malaria outbreak investigation, 50.6 % of the malaria cases were males [8].

Age group of 15 years and greater than 15 years were more affected with AR of 72 per 100 populations than other age group. Similar studies were done in Zimbabwe (50 per 100) and it is higher than that of Zimbabwe [9]. This is might be due to higher ages have lower immunity and the productive ages were in night activities.

This study revealed that, the high proportion of Plasmodium falciparum (75%) and p.vivax (25%) cases shows difference as compared to the nationally registered proportion of Plasmodium falciparum and plasmodium Vivax which is 60% and 40% respectively [10]. Most of studies done on malaria were similar to our study. During malaria epidemics, the dominance of p. falciparum over the other species is common in Ethiopia. This finding also disagrees the study conducted in Bena Tsemay district in SNNPR to assess prevalence and risk factors of malaria where proportion of p. falciparum accounted 64.3% [11]. The possible reason for this high case positive rate of this outbreak maybe linked to high sensitivity of the Malaria rapid diagnostic test.

The national malaria prevention and control strategy recommends application of IRS as at least once in a year with 100% coverage, and at least one ITN per two people in malaria high-risk areas [12]. Despite this fact, IRS was not applied prior to the outbreak rather on risky area applied who had stagnant water around their home and early replacement of ITNs was not done. This might be related to poor planning and /or implementation of malaria prevention and control strategies. Households who had been using

the ITNs other than its intended purpose were also observed. This could be due to poor monitoring of the communities after distributing the ITNs. In our study area households have 2–3 bed net and 4–6 bed nets (OR 0.377, 95% CI; 0.142–1.000 and OR 0.057 95% CI; 0.010–0.335 respectively) less likely to be affected by malaria infection than those who have one and no have bed nets. This may be due to lack of enough bed nets for those who have many family members as recommended [12].

presence of intermittent rivers nearest to the community, OR 1.806 (95 %CI; 1.032–3.162) and open deep well OR 1.768 (95% CI ;1.009–3.095) were independent risk factors for onset of the outbreak of malaria. A similar study done in Northwest Ethiopia, Smada District, Amhara region OR 5.41 (95 %CI; 2.11–10.00) and our study is lower than that of Asgede Tsimbla district and the above one. This independent risk factor was due to the fact that following high rainy season there will be flooding as a result, in lowland areas the water stays as stagnant water facilitating mosquito breeding result in malaria infection [13].

The odds of developing malaria among people who used ITN sometimes and never use ITN was nearly 32 and 10 times (AOR; 32.098; 95%CI: 3.570–288.633 and AOR 10.214; 1.163–89.725 respectively) compared to who use ITNs frequently. Similar finding was also reported from study in India [14] and it is higher than that of India. This might be due to lack of knowledge about the use of ITN. Having poor knowledge related to malaria prevention and transmission, stagnant water and tick grass had no association with malaria illness in multivariate analysis (OR = 0.83; 95%CI; 0.401–1.716). Similar study is done in Dasenech wereda in South Ommo in SNNPR [15].

As a limitation two HCs were not included in the study because of their topography difficulty and the number of cases somehow small.

Conclusion And Recommendation

In conclusion there were malaria outbreak in Bolosso Sore wereda over two months starting from the mid of 17th Epi Week to 28th epi. week. Presence of intermittent rivers nearest to the community, open deep well near to their home and usage of ITN (those ITN use sometimes and never use ITN) were independent risk factors for onset/occurrence of the outbreak of malaria. And IRS, tick grass, staying overnight, number of ITN those given to the community or poor accesses, broken glass and plastic container were less risk factor for the infection of malaria than their counterparts or preventive factors for malaria infection. And also, there were no malaria repellents all over the wereda. And the malaria patients or risky kebeles of their homes were not screened.

Therefore, malarias areas of the wereda insecticide treated bed net should be distributed for all households according to their family member. Beside this, utilization of bed net should be monitored and optimized. Regular indoor residual spray per required standard should kept in place. Identification and removal of potential mosquito breeding sites should be conducted by maximizing community participation. And during the outbreak they should be use line list format that is used for response.

Declarations

Ethical Consideration

All participants were informed about the objective of the study, confidentiality of the participant was assured and informed consent was sought from and given by the participants, with the knowledge they were free to withdraw at any time. Ethical clearance was obtained from the institutional review board of Ethiopian public health institute and the support letter was written from Welayta zone health bureau to Bolosso sore wereda health office.

Consent for Publication

Not applicable

Availability of Data and Materials

The dataset is available on from Mr. Awol Dawud of the corresponding author.

Competing Interests

We have declared that we have no competing interests.

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We have no any means of funding of this research.

Authors' Contributions

AD designed the study, participated in the training and data collection, performed analysis, interpretation of data, drafted the paper and prepared the manuscript. HH and ZA assisted in the design, participated in data analysis and comment the drafts of the manuscript. All authors read and approved the final manuscript.

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References

1. Daddi J, AAea. Analysis of malaria surveillance data, Biomed central, 2012:1–14.
2. FMOH, World malaria day, 25 April 2011.
3. Draft Guideline for malaria vector control in Ethiopia; Malaria and Other Vector-borne Diseases Prevention and Control Team; Diseases Prevention and Control Department; Federal Ministry of Health, Addis Ababa, Ethiopia, January 2002.
4. Epidemiology and Ecology of Disease and Health in Ethiopia, Third Edition, Edited by:Yemane Berhane; Damen Haile Mariam; Helmut Kloos, Ethiopia, 2011.
5. Addisu Workineh Kassa MAT, and Addisu Gize Yeshanew. Assessment of Control Measures and Trends of Malaria in Burie-Zuria District, West Gojjam Zone, Amhara Region. Hindawi: North West Ethiopia; 2015. pp. 1–5.
6. Gemechu Shume Bejiga. Malaria Outbreak Investigation and Intervention in Ilu woreda. Ethiopia: South-Western Oromiya; 2013.
7. World malaria report 2018. World Health Organization 2018, ISBN 978-92-4-156565-3.
8. Nigatu, Tarekegn. Malaria Outbreak Investigation, Chano-Mile kebele. Arbaminch Zuria Woreda, SNNPR; 2013.
9. Rashmi, Sharma. Epidemiological investigation of malaria outbreak in village Santej, district Gandhi Nagar (Gujarat), Nov, 2006, Indian J. Prev. Soc. Med. Vol. 37 No 3&4.
10. Tinashe KUREYA, Augustine NDAIMANI, Maxwell MHLANGA, Malaria Outbreak Investigation in Chipinge, Zimbabwe: A Case-control Study, Iran J Parasitol: Vol. 12, No. 3, Jul-Sep 2017, pp.423–432.
11. Debo W, Kassa H. Prevalence of malaria and associated factors in Bena Tsemay district of pastoralist community. Southern Ethiopia; 2016.
12. Wondimu MS, Woldesemayat EM, Aselle TA. Malaria Outbreak Investigation in Pastoral Communities of BenaTsemay District, Southern Ethiopia: A Case Control Study. American Journal of Health Research. 2019;7(3):31–7.
13. Baymot Workineh FA, Mekonnen. Mekonnen Sisay and Kedir Abdela Gonete, Malaria outbreak investigation and contracting factors in Simada District, Northwest Ethiopia: a case–control study, Workineh et al. BMC Res Notes. 2019;12:280.
14. Yadav K. Socio-economic determinants for malaria transmission risk in an endemic primary health centre in Assam, India. Infectious Diseases of Poverty. 2014;3:19.
15. Seyoum, Wendafrash. Malaria outbreak investigation and Response in Dasenech District. SNNRP: South Omo zone; 2018.

Figures

Figure 1

Epidemic threshold of malaria in Bolosso Sore Woreda from 2014

Figure 2

Epicurve of Bolosso Sore woreda based on PHEM weekly data Wolayta Zone, SNNPR, and Ethiopia September, 2019

Figure 3

Description of Age and sex of Bolosso Sore wereda, September 2019

Figure 4

Small Damp or Building for fish breeding in Achura Cluster Tiyo kebele.

Figure 5

Stagnant water that found in Achura Cluster Tiyo Kebele