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A Malaria Outbreak in Ameya Woreda, South-West Shoa, Oromia, Ethiopia, 2012: Weaknesses in Disease Control, Important Risk Factors

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Abstract: Malaria is endemic in Ethiopia but regional health bureaus have set goals for elimination of the disease through the implementation of aggressive malaria control and eradication measures. In May 2012 an increased number of malaria cases were reported from Ameyaworeda, South-West Shoa, Ethiopia, which previously had been targeted for elimination. We investigated to understand associated risk factors and propose control measures.We reviewed data from health post records from 2008 to 2012 to identify the baseline incidence of malaria for Ameya. We defined a confirmed case as a patient with malaria confirmed by microscopy or a rapid diagnostic test. From May 18 to June 10, 2012 we randomly selected 144 newly diagnosed malaria patients and compared with 144 community matched controls. Multivariate analysis was performed using Epi Info version 3.5.3. We also assessed environmental conditions.The baseline incidence rate for malaria prior to the outbreak was 1/1000 population. Between March 2012 and May 2012 4768 cases were reported with a peak during May [Incidence: 37per 1,000 and no fatalities]. Using multivariate analysis, cases were found to be less likely to use ITN's [OR: 0.09; 95%CI 0.05-0.16] and less likely to spray their houses [OR: 0.45; 95%CI 0.21-0.97] when compared with controls. Environmental assessment revealed the presence of stagnant water, which was favorable for mosquito breeding. We identified several factors that contributed to the outbreak, which included a low utilization of ITN's, ideal conditions for vector breeding, a weak case detection system. We recommended and helped implement a community awareness program on the utilization of ITN's, environmental management and focal indoor residual spray (IRS).

Keywords: Outbreak, Malaria, Odds Ratio, ITN's, IRS

1. Background

Ethiopia is among the few countries with unstable malaria transmission. Consequently, malaria epidemics are serious public health emergencies [1]. While malaria is mostly an endemic disease, it may also occur as outbreaks, for example in areas with low seasonal transmission [2,3,11,12].

Factors that may cause outbreaks include an increase in vector breeding sites, migration of infected people into a vector-rich area populated with susceptible individuals, arrival of new efficient vectors, breakdown of vector control measures, resistance of the parasites to treatment and resistance of the vectors to insecticides [2, 3,9,12]. Malaria epidemics in Ethiopia can occur as a result of variability or changes in the rate of infection and population immunity [1,5,11]. Generally, epidemics occur in places where there is low and unstable malaria transmission, and where people have low or no immunity [1,13]. However, there could be epidemics in high transmission areas if there is deterioration of health system, interruption of anti-malarial measures or migration of non-immune individuals, such as population movement in search of labor to these areas [1].

Since 1958, major epidemics of malaria have occurred at approximately 5-8 year intervals, though recently there has been a trend towards smaller-scale, more frequent, sporadic epidemics and seasonal case build ups [1]. Since 2005, Ethiopia has strengthened the health system with the establishment and subsequent expansion of the Health

Extension Program (HEP), allowing closer monitoring of epidemic-precipitating factors at the local level [1,14]. In 1998, a widespread severe malaria epidemic occurred in most highland as well as lowland areas in the country [1]. Many localized but severe outbreaks of malaria occurred in Amhara and South Nation and Nationality People Regional States, leading to widespread epidemic malaria in highland and highland fringe areas (up to 2,500 meters) in 2003[1].

The main vector control activities implemented in Ethiopia include Indoor Residual Spray (IRS), Long Lasting Insecticide Treated Nets (LLIN's) and mosquito larval source reduction [1, 3].

Malaria diagnosis consists of a patient's clinical assessment, microscopic examination of blood slides and use of multi-species Rapid Diagnostic Test (RDT) in accordance with the level of the health facility [1,13]. Microscopic diagnosis remains the standard of diagnosis in health centers and hospitals of different levels, whereas multi- species RDTs are the main diagnostic tool at the health post level [1,13]. Artemesinin Combination Therapies (ACT) is the first-line drug for treatment of uncomplicated P. falciparum malaria. Oral quinine is used as the first-line treatment for pregnant women during the first trimester and for children of less than 5 kg. Chloroquine is used for treatment of P. vivax. Radical cure with primaquine is recommended for patients with P. vivax, residing in non-malaria-endemic areas that are treated at the health center or hospital level [1].

While the national malaria control programme struggles to control malaria in Ethiopia, outbreaks occurred in some areas of Oromia region and also in SNNPR and Amhara regions. Amaya woreda of South-WestShoa zone found in Oromia Region is one of the districts selected for elimination of malaria in 2015 by Regional Health bureau in accordance with National Malaria Strategic Plan stated as malaria elimination in selected geographical areas with historically low malaria transmission by 2015, where universal coverage of malaria prevention interventions and strengthened surveillance has been well established. The out-break is detected early by using weekly second largest number in a five year dataset (the third quartile threshold) for health posts with five years data set, and doubling of the recent year weekly cases threshold for health posts with at least single year data. A total malaria case of 3871 was registered only in May. Plasmodium *falciparum* accounted for 87% of the district malaria cases in 2012 (South-West Shoa Zone Health Department, Oromia region, 2012). In Ameya district, malaria had been endemic in twenty four kebeles even though dramatically reduced in 2010 and 2011 according to the reports of the district to zonal health department.

The total population of Ameya district is 139,975 according to the 2007 Central Statistics Agency population census projection. 115,417 (82.5%) resides in malaria endemic localities. Land is used by subsistent farmers for the cultivation of Maizes, Wheats and Barleys. Small scale irrigation and small streams are also found in the district. There are a few scattered paddy fields. 24 Health Posts (HP) and 4 Health Centers (HC) cover the healthcare needs of the population. This district was investigated to assess its magnitude, identify its determinants and propose control measures.

This outbreak was investigated to assess its magnitude, identify its determinants and propose control measures.

2. Methods

2.1. Laboratory Methods

Laboratory technologists and technicians stained and examined blood slides (thick and thin smears) as part of their routine work with a 100 × oil immersion microscope at four health centers and Health Extension Workers confirm malaria species using Rapid Diagnostic Test.

2.2. Descriptive Epidemiology

A case of malaria was defined as an acute febrile illness with a peripheral blood smear positive for malaria or a positive rapid antigen test in a resident of Amaya between May 18, 2012 and June 12, 2012. Malaria surveillance reports were reviewed for 2007-2012. The 2012 data was compared with the average weekly number of cases during 2007-2011 to determine whether the epidemic threshold (third quartile values of each week) had been crossed. Health care facility records were searched for cases and deaths. Treatment records were reviewed for malaria deaths. Laboratory registers were reviewed to abstract slide examinations results. Rates of malaria by age and sex were calculated using the 2007 census data as denominators. The slide positivity rate was calculated by dividing the total number of slides positive for malaria by the total number of slides examined and expressed as a percentage. Attack rates by area were calculated by kebeles. An epidemic curve was constructed.

2.3. Analytical Epidemiology

A case-control study (using the same case definition) was conducted to examine the effectiveness of personal vector protection practices in the population. Neighbours with no fever for the last three months were selected as healthy controls and matched for age and sex to malaria case patients identified by laboratory detection in between May 18 to June 10, 2012. A standardized questionnaire was used to collect information about selected practices, including use of insecticide treated nets and indoor residual spray with Deltamethrine. Odds Ratio for discordant pairs was calculated using the Epi Info 3.5.3 software (CDC, Atlanta, Georgia, USA) by using multivariate analysis. The fractions of cases attributable to the risk factors (or the failure to use protection measures) in the population was calculated using the classical formula (the proportion of cases exposed multiplied by [odds ratio-1/odds ratio]).

2.4. Environmental Assessment

Selected case-patients and health workers were interviewed to collect qualitative information on potential mosquitoes breeding sites.

3. Results

3.1. Laboratory

Between March 2012 and May 2012 a total of 6,831 blood smears testing done by Microscopy and Rapid Diagnostic Test (RDT) resulted 4768 positive for malaria from which 4,004 (84%) had *P. falciparum* and 764 (16%) had *P.*vivax.

3.2. Descriptive Epidemiology

Amaya woreda reported 4768 cases of malaria (Attack rate: 50 per 1,000, Table 1) and 17 malaria deaths (Case fatality: 0.2%, Table 1) between March 2012 and May 2012. The alert threshold (i.e., the second largest number of reported cases of five year data set from 2007-2011) had been almost reached in March 2012 and crossed in April 2012 in all health facilities found in malaria risk area. The proportion of slides that were positive (referred to as slide positivity rate in Amaya) increased from 2.54% in 2011 to 68.9% in 2005. On that basis, the event was determined to be an outbreak and not a seasonal increase in the number of cases.

The baseline incidence rate for malaria prior to the outbreak was 1/1000 population. The incidence rate of malaria increased from 1.1 per 1,000 in March 2012 to 3 per 1,000 in April 2012 and peaked in May 2012 (37 per 1,000)(Table 1 and Figure 1). Incidence of malaria with *P. falciparum* and *P. vivax*peaked at the same time. There was no death during the epidemic time (Table 2).

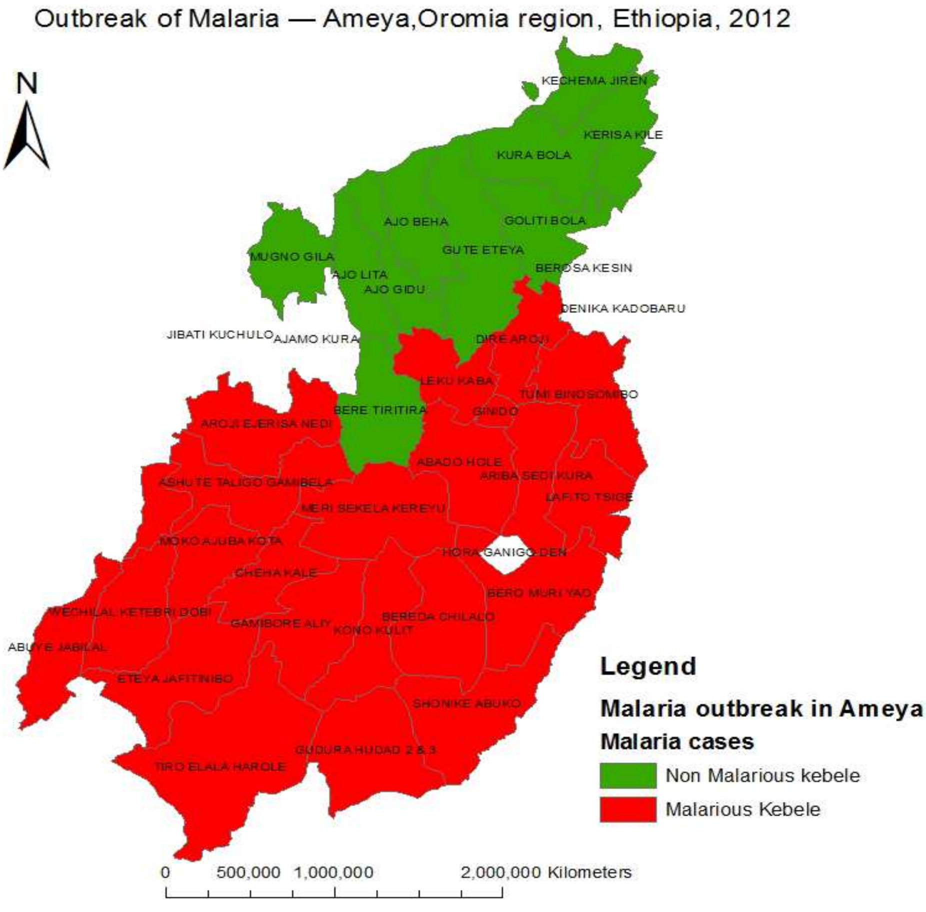

Figure 1. *Malaria risk by kebeles -Ameya, 2012*

Malaria cases reached alert threshold in April, 2012**.** The out break stayed for about 12 weeks(3 months). This might be due to lack of early detection of outbreak, insufficient interventions covering all kebeles at the same time and inherent nature of the disease.

Table 1. *Malaria trend-Ameya, South West Shoa, Oromia, Ethiopia: 2000-2004 E.F.Y*

Month	**March**					**April**					**May**				
Year E.F.Y	**2000**	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
Total malaria	12	60	168	24	163	20	389	344	19	366	45	68	318	134	4229
P.falciparum	6	38	55	6	92	20	156	48	6	282	45	32	29	49	3622
P.vivax	6	22	28	18	71	0	233	255	13	84	0	36	201	85	607

As indicated in the above table malaria increased steadily in March and April when compared to previous years. HEW's were treating malaria clinically before RDT is fully scaled in the woreda. In May 2004 E.C there was high increment indicating malaria outbreak.

***Table 2.** Malaria cases and deaths by age and sex-Ameya, South-West Shoa, Oromia, Ethiopia, 2012*

Characteristics		Population	Cases	Deaths	Case Fatality Ratio(CFR)	Attack Rate per 1000(AR)
Age	0-4	19044	762	0	0	40
	>4	96373	4006	0	0	41
Sex	Male	57706	2760	0	0	47.8
	Female	57711	2008	0	0	34.8
Total		115417	4768	0	0	41.3

There is no significant difference among children under five years and above five years population in the woreda indicating under five population is still at risk age group. In this outbreak males have higher risk of acquiring the disease when compared to females. This might be due to many of the males sleep outside of the house under the roof.

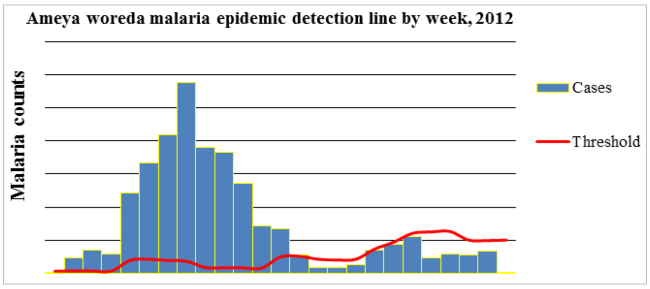

***Figure 2.** Malaria outbreak-Ameya, South West Shoa, Oromia, Ethiopia, 2012*

3.3. Analytical Epidemiology

Randomly selected 144 newly diagnosed malaria patients and 144 community matched by sex, age and place of residence controls were included in the case control study. Using multivariate analysis, utilization of Insecticide Treated Nets (ITN's) was associated with lower odds of malaria (Odds Ratio (OR): 0.09, 95% confidence interval: 0.05-0.16, attributable fraction in the population: 72.7%). Indoor Residual Spray (IRS) with Deltamethrine was also associated with lower odds of malaria (OR: 0.45, 95% confidence interval: 0.21-0.97, attributable fraction in the population: 27%). Destructing mosquito breeding sites was uncommon among both cases and controls (15.4% and 28.5%, respectively) and was not associated with illness(OR: 0.28, 95% confidence interval: 0.26-1.12). Participating on community conversation on malaria prevention and control activities was also uncommon among both cases and controls (20.3% and 26.4%, respectively) and was not associated with illness (OR: 0.71, 95% confidence interval: 0.41-1.24).

3.4. Environmental Assessment

There was no recent unusual population migration for the area. Stagnant water bodies had larvae of anopheline mosquitoes. Indoor residual spray coverage of households with Deltamethrine was under the 85% recommended by World Health Organization (WHO), 76.8% according to Amaya woreda Health Office report.

4. Discussion

Outbreaks of malaria are often complex, multi-factorial and may have natural and human-made determinants [2, 4]. During the outbreak investigation time it was found that health facilities were using clinical malaria cases which were not confirmed by Rapid Diagnostic Test (RDT) or microscopy as threshold line for monitoring malaria epidemic on chart. In 2012, in Amaya, an outbreak investigation led to suspect that a number of factors operated. These included stagnant water bodies where the vector bred, inadequate vector control measures, low implementation of personal protection like use of ITN's. In addition, weak case detection delayed the response. During this outbreak, identification of risk factors was challenging. Traditionally, in field epidemiology, outbreak investigations include a first step of hypothesis generation and a second step of hypothesis testing. The hypothesis generation used in this investigation process involved a study of the geographical area contributed for mosquito breeding. This spatial analysis pointed to the stagnant water bodies of the malaria-affected villages. This hypothesis was not tested using a classical case-control approach using individuals as the sampling unit. A similar analytic approach in India indicated that people living closer to established vector breeding sites were at higher risk for malaria than those living farther away [2]. In addition to vector proliferation, low coverage of indoor residual spraying may have contributed to this outbreak. In 2012 Deltamethrine spray coverage was 76.8%. This is lower than the WHO recommended minimal level of 85%. This low coverage would at most lead to a very modest effect on transmission [2]. Malaria incidence is influenced by the practices of the population in terms of personal protection. These were explored using a case-control study that indicated that use of mosquito nets was associated with a lower risk. We found that a large proportion of the population (91.7% of controls) slept under a net which is similar to study conducted in Columbia found that 96% of controls slept under nets benefited from not getting from malaria [9]. The health authority of Amaya woreda distributed 48090 insecticide-treated bed nets among the affected population in 2011 which is estimated to be 100% coverage. But according to the Amaya woreda Health Office report ITN's utilization was

79%. But Malaria Indicator Survey of 2007 estimates ITN's utilization to around 60%. Further measures are needed to increase the utilization of insecticide-treated bed nets to reduce morbidity and mortality due to malaria.

5. Limitation

The present investigation suffered from a number of limitations with respect to the rudimentary entomological investigation. First, the species of the larvae found in the breeding sites could not be checked. Second, a vector incrimination study with a dissection of the salivary glands of the adult mosquitoes caught could not be conducted for detection of sporozoites of the malaria parasite. Thus, Anopheles*gambiae*s. l. (presumably *An. arabiensis*) and Anopheles *pharoensis* could not be conclusively identified as the vectors involved in the outbreak. Of these two vector species; *An. arabiensis*is usually the more efficient in many areas of Ethiopia. Overall, these two anopheles species were the only ones identified in stagnant water bodies of Ethiopia and previous incrimination studies pointed to both species as predominant vectors.

6. Conclusion

The malaria outbreak in Ameya in 2012 was multi-factorial. Determinants included vector breeding in stagnant water bodies, low implementation of personal protection like ITN's utilization, unsatisfactory coverage of IRSand weak case detection.

Recommendation

A number of recommendations were formulated. First, all potential vector breeding sites must be identified for implementation of larval control measures. Second, vector control measures need to be scaled up to reach the recommended threshold. Third, the population needs to protect itself using insecticide-impregnated mosquito nets. Those need to be introduced on a broader scale, using financial assistance for those who are unable to use it and promoted with messages to ensure proper use. Fourth, weekly rather than monthly reporting intervals must be used to detect outbreaks early through the calculation of weekly epidemic thresholds on the basis of previous five years data by taking only confirmed malaria cases.

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