The Ninth Ethiopian Malaria Research Network Symposium Proceeding

University of Gondar

November   28-29, 2017

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Acknowledgment

The 9th Malaria Research Network Symposium was conducted by the collective and unreserved efforts of various organizations and individuals. The Malaria Research Network of Ethiopia would like to extend its heartfelt appreciation to those organizations and individuals who participated in organizing this symposium. First and foremost the network acknowledges the involvement of the FMoH/EPHI in providing guidance and active participation of all the events of the network. Our special thanks goes to University of Gondar for hosting the symposium with great hospitality, Addis Continental Institute of Public Health/Strengthening Malaria Monitoring and Evaluation Systems (ACIPH/SMMES) project for the well-organized coordination of the symposium, the junior and senior researchers who presented their research work and all other participants of the symposium. Finally, our sincere gratitude goes to USAID/PMI, this symposium wouldn't be a reality without the generous financial and technical support of PMI-Ethiopia and its team members who have assisted the network since its inception.

Summary

The ninth Malaria Research Network of Ethiopia (MRNE) symposium was conducted at University of Gondar "Science Amba" auditorium on 28th and 29th of November 2017. The theme of the symposium was: "**Path ahead; Ending malaria for Good**!" The theme reflects the vision of a malaria-free world set out in the "Global technical strategy for malaria 2016-2030". The symposium was organized by Addis Continental Institute of Public Health (ACIPH)/Strengthening Malaria monitoring and Evaluation Systems (SMMES) project in collaboration with Federal Ministry of Health (FMoH), Ethiopian Public Health Institute (EPHI) and University of Gondar (UoG). The overall purpose of the network was to create a platform to strengthen linkages between researchers, program personnel, universities, policy makers, and other malaria stakeholders through sharing of research findings, evidences and policy briefs.

The symposium was honored by the presence of senior officials and high-level experts from FMoH, EPHI, UoG, USAID/PMI and ACIPH. All these dignitaries have had a chance to say few words regarding the network in the first session and the symposium was officially opened by Dr. Asrat Atsedewoin, Academic Vice President of the host university, UoG. More than 170 participants from FMoH, Regional Health Bureaus, Universities, governmental, non-governmental organizations and post graduate students from UoG attended the symposium.

In line with the theme of the symposium, Mr, Dereje Dilu from FMoH delivered a presentation which was followed by an overview of the malaria situation in Amhara regional state presented by Amhara regional health bureau malaria prevention, control and elimination program (MPCEP). Senior malaria researchers and members of the network also presented policy-briefs and innovative research findings. Twenty-two abstracts were selected,17 for oral and five for poster presentation, based on set criteria considering relevance to Ethiopian malaria prevention, control and elimination program. The selected papers were classified under four thematic areas: malaria epidemiology, entomology, malaria prevention and control interventions, and malaria clinical pharmacology and presented in different sessions. The final session of the symposium, focused on the network's future direction and a number of opinions were put forward to strengthen the network and sustain the platform. The 10th MRN symposium is tentatively scheduled to be held at Wollo University by the end of November 2018. However, this depends on FMoH decision of merging the network symposia with the annual world malaria day activities.

Acronyms

AAU	Addis Ababa University
AAU/SPH	Addis Ababa University School of Public Health
ACIPH	Addis Continental Institute of Public Health
ACT	Artemisinin Combination Therapy
AOR	Adjusted Odds Ratio
CI	Confidence Interval
DDMS	Disease Data Management System
EFETP	Ethiopian Field Epidemiology Training Program
EIA	Enzyme Linked Immuno Assay
ELISA	Enzyme Linked Immuno Sorbent Assay
ENACT	Enhanced Climate Service
EPHI	Ethiopian Public Health Institute
FGD	Focus Group Discussion
FMoH	Federal Ministry of Health
FTAT	Focal Test and Treat
GHSC-PSM	Global Health Supply Chain Program-Procurement and Supply Management
GPS	Global Positioning System
HDAMA	Health Development and Anti Malaria Association
HDSS	Health and Demographic Surveillance Site
ITN	Insecticide Treated Nets
KII	Key Informant Interview
LAMP	Loop Mediated Isothermal Amplification
LLIN	Long Lasting Insecticide Treated Nets
LMICs	Low Middle Income Countries
MRNE	Malaria Research Network of Ethiopia
MRNS	Malaria Research Network Symposium
MU	Mekele University
NMA	National Meteorology Agency

NMPCEP	National Malaria Prevention Control and Elimination Program
OPD	Outpatient Department
PATH MACEPA	Malaria Control and Elimination Partnership in Africa
PFSA	Pharmaceutical Fund and Supply Agency
PMI	President's Malaria Initiative
RBM	Roll Back Malaria
RCD	Reactive Case Detection
RDT	Rapid Diagnostic Test
RHB	Regional Health Bureau
SBCC	Social Behavioral Change Communication
UoG	University of Gondar
USAID	United States Agency for International Aid
WHO	World Health Organization

Session I: Opening Ceremonies

Welcoming speech was given by Dr. Sisay Yifru, Dean, College of Health Sciences, University of Gondar (UoG). On behalf of the University and himself, he warmly welcomed participants to the 9th Malaria Research Network Symposium (MRNS) and to the historic city of Gondar. He reminded attendees about UoG's historic relation with malaria by mentioning the relationship of the deadly epidemic outbreak in 1950s which claimed the lives of thousands and prompted the establishment of the college and training center. He then discussed the challenges the world is facing in combating malaria and acknowledged the importance of the establishment of the Malaria Research Network of Ethiopia (MRNE). Dr. Sisay ended his speech expressing hope that the discussions in each of the sessions will be productive and fruitful.

Following the welcoming speech key note addresses were given by relevant institutions. Ms. Hiwot Teka, Malaria Advisor, at the President's Malaria Initiative (PMI) Ethiopian program, delivered her key note address. She described the efforts and achievements thus far towards reducing mortality and morbidity due to malaria in the country and highlighted the launch of Ethiopia's plan to eliminate malaria nationally. Finally, she finished her speech by acknowledging the benefits of the MRNE platform to enhance information sharing for decision makers.

The next keynote address was delivered by Dr. Adugna Woyessa, representing EPHI. He began his speech by welcoming participants and praising UoG for hosting the event on behalf of EPHI and MRNE. He mentioned that EPHI has been leading this network in collaboration with PMI and Addis Continental Institute of Public Health (ACIPH) since 2014. Dr. Adugna stated that the platform is an umbrella organization where researchers, program personnel, and policy makers come together and share available malaria related research findings as well as evidence based best practices for continuous program improvement. These, obviously, will contribute towards the goal of malaria elimination.

The third keynote was delivered by Professor Yemane Berhane, Director of Addis Continental Institute of Public Health (ACIPH), who expressed the pleasure on behalf of himself and ACIPH to assist the strengthening of the network. He also recognized the achievements in reducing malaria morbidity and mortality in the country and globally through the unreserved collaboration of a number of stakeholders/partners. However, he indicated that despite all those achievements,

malaria continues to be one of the most important infectious diseases impacting health in Sub-Saharan African countries. He stressed the importance of the MRNE platform in strengthening malaria control, prevention and elimination programs through the sharing of evidence and the prioritization of malaria related research areas among stakeholders.

The last key note was delivered by Mr. Dereje Dillu, representing the National Malaria Prevention, Control and Elimination Program (NMPCEP) within the Federal Ministry of Health (FMoH). Mr. Dereje started his speech by reminding the audience about Ethiopia's achievements in shrinking the malaria map and the overall progresses observed related to the fight against malaria through scale up of malaria intervention since 2005. On his remark, He mentioned the decline of malaria related morbidity and mortality by 50% in 2010 and 60% in 2015 from the figure in 2005. Building on those achievements and the global momentum to end malaria from the globe, the country is moving toward the new initiative of eliminating malaria using a phase-based strategy. Currently, 239 districts/woredas from six regions are selected for malaria elimination by 2020 (Phase I). Before 2030 all districts/woredas in the country will join the elimination initiative based on epidemiological and operational capacity criteria set by the WHO. He then pointed out the operational gaps and bottlenecks that compromise the progress of the national malaria program and indicated the need of scientific evidences in identifying gaps and utilization of the information by policy makers and program officers. Mr. Dereje ended by wishing participants a fruitful stay, acknowledging the organizers and applauding the existence of the research network and its effort in sharing the evidence it has generated with policy makers and program persons.

The opening speech was then given by Dr. Asrat Atsewdewoin, Academic Vice President, UoG, guest of honor of the symposium. Dr. Asrat warmly welcomed all the participants on behalf of the university and himself and also mentioned the malaria outbreak in 1950s which was the fuel for the establishment of the college. Commending the achievements the country has reached in reducing morbidity and mortality due to malaria, he stressed the need to continue the work to combat malaria once and for all as it is still causes significant negative impacts on the physical, social, and economic health of Ethiopia. He then briefed the participants about the newly inaugurated malaria training and research center at Maksegnit which, he believe, will contribute

to malaria prevention control and elimination plan of the country. After acknowledging the organizers he announced the official opening of the symposium.

Session II: Malaria program overview and others

In this session, two presentations by delegates of FMoH and Amhara RHB, were made regarding the malaria situation in the country and the region respectively. Following these, three policy briefs were presented. These were: *Temperature Trends Across Ethiopia Highlands Highlight New Areas at Risk of Malaria;* by Dr.Adugna Woyessa from EPHI*, Automated Diagnostic Platform, Data Management System and Innovative Communication Tool, for Improving the Impact of Malaria Vector Control Interventions in sub-Saharan Africa* by Professor Delenesaw Yewhalaw from Jimma University and *The Genie's LAMP: applications in malaria prevention and control for Ethiopia* by Prof. Dylan Pillai from University of Calgary, Canada. The session was moderated by Prof. Ahmed Ali from Addis Ababa University School of Public Health (AAU/SPH).

Session Discussion

Following these very important and interesting presentations there was thorough discussion. Some of the questions raised by the participants include: how can we be sure that the Ethiopian malaria map shrinkage is due to NMCEP intervention activities? Mr. Dereje in responding to this question appreciated the importance of the question and acknowledged the difficulty in attributing all the achievements to the program alone. He stressed, however, that the scale up of malaria intervention and expansion of health facilities since 2005 has significantly increased the access to diagnosis and treatment of malaria which could be considered a primary reason for the achievements. Question was forwarded for Mr. Tekelehaymanot from Amhara RHB MPCEP, on the use of epidemiological data for district stratification; would it be the same if other variables are considered? Mr. Tekelehaymanot acknowledged the limitation of using epidemiological data alone because there might be both malaria free and malarious kebeles within a woreda and believe that the result of the stratification may be different if other variables were used. Other responses to the questions raised include: Dr. Adugna's response to the concern regarding the quality of data was; "the data presented here is from Enhanced Climate Service (ENACTS) which is data analyzed by experts in the field. This makes the data presented of high quality." The questions raised for Prof. Delenesaw were concerns regarding sensitivity of the Lab Disc when

compared with other tools and its availability. He responded that the Lab Disc is highly sensitive, of high quality and easy to use. He also state that it is very close being available for use in malaria prevention and control. The last point raised was regarding readiness, sensitivity and applicability of LAMP to be used for malaria diagnosis. Prof Dylan responded that the tool hasn't yet been approved by WHO for use, however, he informed the audience that the team is getting closer to get the approval and make the tool ready for use. He also added that the tool is sensitive compared to PCR. Concerning the applicability, he indicated that it can be performed easily and can also be used in resource limited areas such as facilities without electricity.

Session III: Malaria Epidemiology and others

In this session, four abstracts focusing on the epidemiology of malaria were presented. The session was moderated by Dr. Fikadu Massebo from Arba Minch University and Dr. Kassahun Alemu from UoG. The papers presented were: ***Population Movement as a Risk Factor for Malaria Infection in High-Altitude Villages of Tahtay-Maychew District, Tigray, Northern Ethiopia: A Case-Control Study*** by Mr. Mebrahtom Haile, ***Five years malaria trend analysis of Woreta Health Center, Northwest Ethiopia*** by Mr. Awoke Derbie, ***Malaria Surveillance System Evaluation in Ganta-Afeshum District, Tigray Region, Ethiopia, 2016: Challenges to malaria Elimination in Low transmission Area*** by Mesfin Wubishet and lastly ***Reactive case detection for malaria in Amhara National Regional State, Ethiopia: Descriptive and impact evaluation analysis*** by Mr. Asefaw Getachew. The abstracts are annexed below. The summary of the discussion points were as follow:

Session Discussion

Questions were raised for each presenter. The first presenter was asked if he had included malaria breeding sites in the assessment and which type of malaria vector control intervention he suggests for such cases. Mr. Mebrahtom said, the objective of the study was to assess movement as a risk factor for malaria infection in high altitude areas, therefore didn't include malaria breeding sites in his study. He recommended that in addition to the existing efforts to control and prevent malaria in endemic areas targeting those people who frequently travel to malarious areas is crucial to malaria prevention and control activities. The next question was for Mr. Awoke about the limitation of facility-based data in estimation of the malaria prevalence and whether they collected information about travel history in the study. He responded that the investigators

assume the facility data use microscopy, which is the gold standard for malaria diagnosis, is a good proxy for the prevalence estimation. Regarding the travel history, since this is retrospective study that used data from the laboratory registration book, travel history was not considered which he acknowledged is limitation of the study. Other comments given for Mr. Awoke were not to compare the findings with the national estimates and to use recent publication for referencing. Question raised for the third presenter was regarding the health service coverage, which was reported as 126%, what denominator was used? Mr. Mesfin responded that the coverage was calculated using the national standard which recommends one health center to serve up to 25,000 people. The number of clients who received health services in the area were above the standard. He was advised to correct the coverage, which should never be more than 100%. The last question in this session directed to Mr. Asefaw was if the investigators consider index case inhabitance in the study case estimation and took GPS location of each of the participating household collected. Mr. Asefaw replied that this study didn't consider index case inhabitance as it is a resource intensive task. GPS was not taken and he he acknowledge this limitation of the study. GPS wasn't taken because unavailability of smart phones by Health Extension Worker's (HEW) and the human resource shortage (one HEW is usually assigned many households to follow).

Session IV: Malaria Entomology

This session was centered on malaria entomology or vector behavior. Four papers were presented and the session was moderated by senior entomologists, Dr. Meshesha Balkew from FMoH and Prof. Delenasaw Yewhalaw from Jimma University. The titles of the papers presented were; *Physico-chemical and biological characterization of anopheline mosquito larval habitats (Diptera: Culicidae): implications for malaria control* by Dr. Seid Tiku, *Investigations of host-seeking behavior and hourly biting rhythm of malaria vectors in Chano Mille in southwest Ethiopia: an experimental study* by Ms. Melkam Abiye, *A Unique Plasmodium falciparum K13 Propeller Gene Mutation in Northwest Ethiopia* by Dr. Abebe Genetu and *Community Based Awarness Raising and Behavioral Change Communication to Reduce Malaria Burden in Amhara National Regional State* by Mr. Aklilu Getnet.

Session Discussion

Various questions and discussion points were raised in this session regarding validity, study designs, ethical issues and attribution of project impact. The first question was forwarded to Dr. Seid on the generalizability/external validity of the study and he was asked to comment on supporting evidence for wetland preservation which is opposed to the evidence in malaria prevention and control strategies that promote eliminating wetlands since they may serve as a breeding site for mosquito larvae. Dr. Seid replied that trying to eradicate mosquito larvae from permanent wetlands may not be a good vector control management strategy because doing so may negatively affect the occurrence and abundance of mosquito predators. Also, mosquitoes are found to be less prominent in these areas due to predators and competitors. Ms. Melkam was asked questions about ethical issues regarding animal handling and how the clearance was obtained. She was also asked whether there was more supporting evidence and if she had looked into other research supporting the conclusion made by her study that keeping cattle close to human residences increased the exposure – a unique finding. She replied that ethical clearance was obtained from the Arba Minch University ethical board. As to the second question, she took it as comment and will do more literature search. Dr. Abebe was asked if the mutation reported in the study is similar to that of South East Asia which is an AL resistant mutation. He replied that the mutation from the study is completely different. Lastly, a number of comments and questions were raised for the final presenter on the Social Behavioral Change Communication (SBCC) final project report. Some of it were on how the change in knowledge among the community towards malaria was solely attributed to the project? There are many factors responsible for the change or increase in knowledge as it has been reported in other studies like MIS (Malaria Indicator Survey). Mr. Aklilu was also asked what he thinks are reasons for the high Insecticide Treated Nets (ITN) utilization rate of 74% compared with only 38% in MIS. Finally, comment was provided not to compare the terminal report findings with that of MIS and nationally.

Session V: Malaria Prevention and Control Interventions

In this session four papers were presented. Titles of the papers and their presenters were: ***Understanding Malaria Endemicity in Ethiopia through Combined Application of Classical Methods and Enzyme Linked Immuno Assay: Implications for Countries with Different Disease Eco-Epidemiology Initiating Elimination Program*** by Dr. Zewdie Birhanu, ***Knowledge and perception towards net care and repair practice in Ethiopia*** by Honelgn Nahusenay, ***Rural households at risk of malaria did not own sufficient insecticide treated nets at Dabat HDSS site*** by Kindie Fentahun and lastly ***Factors associated with LLINs use in Ethiopia: Multilevel analysis of household survey data*** by Samir Awol. This session was moderated by Ms. Hiwot Teka from USAID/PMI Ethiopia.

Session Discussion

During the discussion questions and comments were raised. The first question was for Dr. Zewdie on the sensitivity of antibody detection technique in malaria endemic area. Dr. Zewdie explained that Enzyme Linked Immuno Sorbent Assay (ELISA) is highly sensitive. It can detect all antibodies against malaria during all stages of the infection and in all types of parasites. Questions and comments forwarded to Mr. Honelgn were; the majority of the respondents were male and probably repair is mostly done by female, what does he think the result may be if most of the respondents were female? Has he noticed any association between knowledge of net care and utilization between different types of nets? Mr. Honelgn's responded that when it comes to net care and repair he had no information as to whether females or males are more likely to be responsible for the task and accepted this as limitation of the study. The other point raised was the significance of the study. Mr. Honelgn explained that the significance of this study was to assess the level of knowledge in the community about net care and repair which is very important for the effectiveness of the Long-Lasting Insecticide Treated Nets (LLIN). The last questions in the session, was to Mr. Samir; what he thinks the reason is for relatively higher LLIN utilization compared to MIS 2015 and what was the association of net use with the housing condition? He explained that the higher LLIN utilization rate seen might be due to the data collection period which was immediately following mass distribution in May 2015. He indicated that there was no association between net utilization and housing condition but there was an association with socio-economic status of the households. This might be indirectly related to the housing condition.

Session VI: Malaria Treatment/Clinical Pharmacology

This session focused on antimalarial activity of different local medicinal plants. Three papers were presented during the session and their title and presenters were: *Evaluation of essential oils extracted from native Ethiopian home garden plants against malarial vector Anopheles gambiae s.l. (Diptera: Culicidae)* by Wondmeneh Jembere, *Smoking local medicinal plants reduced indoor density of malaria vectors and inhibited feeding on host in southwest Ethiopia* by Tekle Olbamo and *Evaluation of Azadirachta indica A. Juss. and Schinus molle L seed and leaf extracts for larvicdal and growth regulation against Anopheles arabiensis Patton (Diptera: Culicidae) under laboratory conditions* by Dr. Getnet Atnafu. The session was moderated by Dr. Kebede Etana from FMoH and the discussion points are summarized as below.

Session Discussion

In this session points were raised regarding the anti-malarial effects of local medicinal plants and ethical issues of the experimental studies. The first question was regarding charcoal use as control and side effects of the smoke. The presenter responded that charcoal is used as control as it is commonly used by the community and that the smoke is used only during peak mosquito mobility time. Side effects of the smoke were measured. Comments given for researcher to try other smokeless mechanisms that may work differently. Regarding the ethical issues all presenters responded that the studies were conducted after obtaining ethical clearance from the respective institutional review boards.

Session VII: Business Meeting: The way forward on Malaria Research Network of Ethiopia future direction

9th MRNE Symposium Business meeting, November 2017

This was the last session of the symposium and focused on discussions regarding the activities done so far as well as those projected to be done in the future. The session was led by Chair of the network (Dr Adugna Woyessa from EPHI) and Secretary (Dr. Ayele Zewde from ACIPH/SMMES Project). Dr. Ayele started by reminding the audience about the background of the MRNE which was established in May 2010. ACIPH through its PMI funded project SMMES,

started supporting the network as of January 2014 during the 5th MRNE symposium conducted in Mekele University. During the establishment of the network in 2010, Addis Ababa University (AAU) was elected to chair the network. However, during the 5th symposium in Mekele, thorough discussion was made and EPHI was elected to chair the network as it is the most appropriate institute to link the network with the FMoH, since it is the research wing of the FMoH with the aim of linking the network with ministry of health. ACIPH was elected as the secretariat. Subsequent symposia were conducted in collaboration with Arba Minch and Jimma Universities, EPHI and now at UoG. By-law and terms of reference of the network were endorsed during the 7th MRNE hosted by Jimma University. The major achievement of the network thus far has been the regular organization of the symposia annually in collaboration with universities throughout the country. The aim of organizing symposia with universities, has two main purposes according to Dr. Ayele; the first is to close the observed gaps between program and research centers by aligning research findings/evidence generated by universities and research centers with the program, and the second is for the benefit of students and faculty of the universities since the forum is a learning forum. Next he raised a major agenda item for discussion which is; engagement of the ministry of health with the network more. Following this Dr. Adugna added points on this issue and mentioned activities that are being done to institutionalize the network with EPHI. He as an example mentioned the initiation of a webpage in the EPHI website dedicated to the network. He indicated that the network should work more hard in linking research works with that of the national malaria program. He also stressed that the network should aim to establish its own scientific journal. The involvement of major stakeholders; FMoH, program implementers (government, like RHBs and non-governmental) and higher institutions need to be strengthened to facilitate smooth knowledge transfer. Following this he opened the floor for suggestion and discussion about the future direction of the network.

Professor Delnesaw complemented Dr. Adugna's point by saying research in resource limited countries should be need based and program/development oriented. E-MRN provides a good opportunity to bring together program and academics. Following this, representatives of FMoH, RHB, universities, research institutes, and other organizations working on malaria prevention and control were given a chance to voice their views and comments regarding the achievements attained and the way forward. Accordingly, the participants acknowledged the activities done by the coordinators and provided recommendations to further strengthen the network management.

The FMoH participants then suggested a way to strengthen the network by giving the example of similar networks for other programs like TB. Based on the experience of the TB-Track, they suggested merging the E-MRN symposia with World Malaria Day. However, there may be strong evidence that there should be two separate symposia in a year (one independent like this one and one coupled with the world malaria day). Discussions should be held FMoH's, NMCEP team to resolve this issue.

The regional health bureau representatives expressed their satisfaction with the symposium and indicated that they will continue to participate in it. The representatives also pointed to the need to strengthen malaria research in pastoralist areas as most of the presentation here did not address or come from these locations.

Other points raised from senior network members and participants include: desire for FMoH to own and take the leadership role of the network, the need to strengthen the contribution of university research centers and participation of all regions, incorporation of other vector borne disease in the thematic areas, clear communication of abstract screening criteria among members, addition of content as one of the criteria, screening committee to have a multidisciplinary team that should actively participate during the selection, and to actively engage national metrology agency since malaria is a disease that is highly dependent on climate variability. Furthermore, they suggested the network develop policy briefs on important points, prepare and publish bulletins (in addition to the proceeding of the symposia) to communicate information to the wider audience through the FMoH and other partners, develop a system to properly archive the works presented so far so that the research and findings are available for the development of policy briefs.

The participant from Wollo University stated that this is his first time to attend the symposium and said it was a goof venue to learn from senior professionals. He also stated the findings provide a great benefit and will help strengthen the countries malaria elimination program. He added that Wollo University is willing and honored to host the 10th MRNE if the members agree.

Following the points mentioned by participants, Dr Ayele (secretary of the network) summarized the following points: a team from the network should meet with the NMCEP to discuss the future direction of the network and reach consensus on whether the network symposia should be merged

with World Malaria Day or not. The venue for the 10th symposium will then be decided following the decision during the upcoming World Malaria Day.

Finally, Mr Dereje, from FMoH/NMCEP delivered the closing remarks. He has thanked all stakeholders including ACIPH, EPHI, UoG, and all invited guests for their participation. In the past few years the Malaria team at the FMoH has been strengthened in all aspects including human resource development. By working together with universities and research institutions they hope to realize malaria elimination by the year 2030 through continued human resource development and provision of institutional trainings for health workers and others. The MRNE coordinators are also expected to incorporate the action points from the proceedings and follow up to ensure they have been properly implemented.

Annex

Annex 1: List of participants

S.no	Name	Organization
1.	Abebe Alemu	UoG
2.	Abiy Menkir	Bahir Dar University
3.	Abiye Tegabu	UoG
4.	Abreham Abere	GHSC-PSM
5.	Aduga Fenta	UoG
6.	Adugna Gedefaw	UoG
7.	Agumas Shibabaw	UoG
8.	Aklilu Getinet	HDAMA
9.	Alebachew Fasil	UoG
10.	Alebachew Shimelash	UoG
11.	Alem Getaneh	UoG
12.	Alemakef Wagnew	UoG
13.	Amare Dasnaw	UoG
14.	Anteneh Anbaw	UoG
15.	Aregawi Yalew	UoG
16.	Asaye Tariku	UoG
17.	Asefa Negash	UoG
18.	Asefaw Getachew	PATH MACEPA
19.	Ashetu Hunduma	ACIPH/SMMES
20.	Asmamaw Halede	AAU
21.	Asnakew Kebede	PATH MACEPA
22.	Atakelti Asefa	UoG
23.	Awoke Derbie	AAU
24.	Awoke Minwuyelet	GHSC-PSM
25.	Bahar Mohammed	SRHB(Somali)
26.	Bamlaku Enawugaw	UoG

27.	Barnabas Achaw	UoG
28.	Bekele Sharew	UoG
29.	Belendia Abdissa	PATH MACEPA
30.	Belete Biadego	UoG
31.	Birehanemeskel Adanke	UoG
32.	Biresaw Tazaye	UoG
33.	Birhanu Dechasa	Debre Berhan University
34.	Birhanu W/Amlak	UoG
35.	Dagmawit Shemeles	UoG
36.	Dagnaneh Milikit	GHSC-PSM
37.	Daniel Alayu	UoG
38.	Daniel Tarekegn	UoG
39.	Daniel Yitbarek	UoG/EFETP
40.	Dawit Melese	Woldia University
41.	Debasu Damtie	UoG
42.	Demeke Genenew	UoG
43.	Dereje Dillu	FMoH
44.	Dereje Getachew	Media
45.	Desalegn Andargie	UoG
46.	Desalegn Nati	UoG
47.	Desalew Kassahun	UoG
48.	Destaw Wagnew	UoG
49.	Dr.Abebe Genetu	UoG
50.	Dr.Adugna Woyessa	EPHI
51.	Dr.Almaz Afera	Debre Berhan University
52.	Dr.Amare Ayalew	Debre Berhan University
53.	Dr.Aragaw Yimer	Wollo University
54.	Dr.Asmare Dereje	Wollo University
55.	Dr.Asrat Atsedewoin	UoG
56.	Dr.Ayele Zewdie	ACIPH/SMMES

57.	Dr.Dylan Tillai	University of Calgary
58.	Dr.Esubalew Tesfahun	Debre Berhan University
59.	Dr.Fantahun Biadglegn	Bahir Dar University
60.	Dr.Fekadu Messebo	Arba Minch University
61.	Dr.Getnet Atenafu	Debre Markos University
62.	Dr.Hilary Johnstone	HJCTC
63.	Dr.Kassahun Alemu	UoG
64.	Dr.Kebede Etana	FMoH
65.	Dr.Meshesha Balkew	NMLP/FMoH
66.	Dr.Mulugeta Aemro	UoG
67.	Dr.Sebsibew Atikaw	Amhara RHB
68.	Dr.Seid Tiku	Jimma University
69.	Dr.Sisay Yifru	UoG
70.	Dr.Walelegn Worku	UoG
71.	Dr.Wossenswged Lema	UoG
72.	Dr.Zewdie Birhanu	Jimma University
73.	Ebisa Turi	UoG
74.	Eden W/Gerima	UoG
75.	Eshetu H/Selassie	UoG
76.	Fantahun Getaneh	UoG
77.	Feleke Mekonen	UoG
78.	Feleke Moges	UoG
79.	Fentahun Megabe	UoG
80.	Fikadu Deme	GHSC-PSM
81.	Firehiwot Workneh	ACIPH/SMMES
82.	Firew Bekele	GHSC-PSM
83.	Fisseha Zewdu	UoG
84.	Garedew Tadele	UoG
85.	Gashaw Amsalu	UoG
86.	Genet Degu	Debre Markos University

87.	Getahun Ayele	UoG
88.	Getaneh Tizazu	UoG
89.	Getnet Ayalew	UoG
90.	Getnet Fetene	UoG
91.	Habite Tesfa	UoG
92.	Habtamu Mihret	UoG
93.	Habtamu Tegenu	UoG
94.	Habtamu Wondifraw	UoG
95.	Habtye Bisetegne	UoG
96.	Harald Noedl	Medical Universty of Vienna
97.	Hirpa Miecha	Oromia RHB
98.	Hiwot Abebe	UoG
99.	Hiwot Teka	USAID/ PMI
100.	Honelgn Nahusenay	ACIPH/SMMES
101.	Jemal Ahmed	Afar RHB
102.	Kalkidan Mekete	DTU
103.	Kasaw Adane	UoG
104.	Kidist Zewdu	ACIPH/SMMES
105.	Kindie Fntahun	UoG
106.	Kirubel Biruk	UoG
107.	Koshu Huka	UoG
108.	Manale Haile	Bahir Dar University
109.	Marachew Asmamaw	UoG
110.	Markos Negash	UoG
111.	Martha Alemayhu	UoG
112.	Mebrahtom Haile	FMoH
113.	Mekonnen Girma	UoG
114.	Melaku Sete	UoG
115.	Melekamu Getahun	UoG
116.	Melese Abate	UoG

117.	Melese Damtie	UoG
118.	Melese Gessie	UoG
119.	Melkam Abiye	UoG
120.	Melkam Amha	UoG
121.	Menberu Teshome	Debre Berhan University
122.	Meseret Alemneh	UoG
123.	Mesfin Wubishet	Mekele Universty
124.	Mezgebu Yehuala	UoG
125.	Miesho G/Yesus	UoG
126.	Mizan Kindu	UoG
127.	Moges Addis	UoG
128.	Moges Tiruneh	UoG
129.	Mohammed Awole	Woldia University
130.	Mohammed Oud	UoG
131.	Molla Debebe	UoG
132.	Mulugeta Melku	UoG
133.	Muluken Belachew	UoG
134.	Nega Desalegn	UoG
135.	Nega Dessie	UoG
136.	Nemera Eticha	UoG
137.	Prof. Delenasaw Yewhalaw	Jimma University
138.	Prof. Mersha Chanie	UoG
139.	Prof. Ahmed Ali	AAU/SPH
140.	Prof. Yemane Berhane	ACIPH/SMMES
141.	Samir Awol	ACIPH/SMMES
142.	Segni Mekonen	UoG
143.	Seid Ali	UoG
144.	Semira Abdelmenen	ACIPH/SMMES
145.	Shambel Gemeda	UoG
146.	Shimelis Gashaw	UoG

147.	Sintayehu Ambachew	UoG
148.	Smeneh Sintayehu	UoG
149.	Solomon Sharew	UoG/EFETP
150.	Solomon Taye	UoG
151.	Tadele Meleka	UoG
152.	Tahir Eyayu	UoG
153.	Tekle Olbamo	Arba Minch Bureau of Agriculture
154.	Teklehaymanot G/Hiwot	Amhara RHB
155.	Temesgen Anteye	UoG
156.	Temesgen Melaku	Debre Markos University
157.	TesfahunTaddege	UoG
158.	Tesfaye Seifu	GHSC-PSM
159.	Tigest Shifraw	ACIPH/SMMES
160.	Tilahun Kebede	FMOH
161.	Tsega Asferaw	UoG
162.	Tsigie Baye	UoG
163.	Wendimsetegtne Amare	UoG/EFETP
164.	Wondmeneh Jemberie	UoG
165.	Yalewayeker Tegegne	UoG
166.	Yenesew Fisiha	UoG
167.	Yeshambel Sitotaw	UoG
168.	Yeshambel Worku	UoG
169.	Yirgalem Meles	Tigray RHB
170.	Yirgalem Ngusea	UoG
171.	Yonas Abreham	DBU
172.	Yonas Adugna	UoG
173.	Zegeye Getaneh	UoG
174.	Zegeye Regasa	UoG
175.	Zemenu Tadesse	UoG
176.	Zerihun Getachew	ENA

Annex 2: Schedule

9th Ethiopian Malaria Research Network Symposium
November 28-29, 2017, University of Gondar

Time	Topics	Presenters
	Day 1	
08:00- 09:00	Registration	ACIPH/UoG
	Session I: Moderator and Master of Ceremony – Dr. Kassahun Alemu/Dr. Ayele Zewde	
09:00- 09:10	Welcome Address	Dr. Sisay Yiferu, Dean, College of Health Sciences UoG
09:10 -09:20	Keynote address	Ms. Hiwot Teka, Malaria Advisor, President's Malaria Initiative (PMI)
09:20- 09:30	Keynote Address	Dr. Adugna Woyessa, Malaria Epidemiologist EPHI
09:30- 09:40	Keynote address	Prof. Yemane Berhane, Director, ACIPH
09:40- 09:50	Keynote address	Mr. Dereje Dilu, FMoH/NMPCEP
09:50- 10:00	Opening speech	Dr. Asrat Atsedewoin, Academic Vise President UoG
10:00-10:30	**Tea Break**	**Organizers**
	Session II: Malaria program overview and others Moderator: Prof. Ahmed Ali/Dr. Wossnseged Lemma	
10:30-10:45	Path Ahead: Ending malaria for good	Mr. Dereje Dilu/FMoH
10:45-11:00	Overview of the malaria prevention, control and elimination program in Amhara Regional State	ARHB representative
11:00-11:15	Temperature Trends Across Ethiopia Highlands Highlight New Areas at Risk of Malaria; Policy Brief	Dr. Adugna Woyessa
11:15-11:30	Automated Diagnostic Platform, Data Management System and Innovative Communication Tool, for Improving the Impact of Malaria Vector Control Interventions in sub-Saharan Africa	Prof. Delenasaw Yewhalaw

11:30-11:45	The Genie's LAMP: applications in malaria prevention and control for Ethiopia	Prof. Dylan Pillai
11:45-12:30	**Discussion**	**Participants**
12:30- 01:30	**Lunch break**	**Organizers**
Session III: Malaria Epidemiology and others Moderator : Dr. Fikadu Massebo/Dr. Kassahun Alemu	
01:30 -01:45	Population Movement as a Risk Factor for Malaria Infection in High-Altitude Villages of Tahtay-Maychew District, Tigray, Northern Ethiopia: A Case-Control Study	Mebrahtom Haile
01:45 -02:00	Five years malaria trend analysis of Woreta Health Center, Northwest Ethiopia	Awoke Derbie
02:00 -02:15	Malaria Surveillance System Evaluation in Ganta-Afeshum District, Tigray Region, Ethiopia, 2016: Challenges to malaria Elimination in Low transmission Area	Mesfin Wubishet
02:15 -02:30	Reactive case detection for malaria in Amhara National Regional State, Ethiopia: Descriptive and impact evaluation analysis	Asefaw Getachew
02:30-03:00	**Discussion**	**Participants**
03:00-03:20	**Tea break**	**Organizers**
Session IV: Malaria Entomology: vector behavior Moderator: Dr. Meshesha Balkew/Prof. Delenasaw Yewhalaw	
03:20-03:35	Physico-chemical and biological characterization of anopheline mosquito larval habitats (Diptera: Culicidae): implications for malaria control	Seid Tiku
03:35-03:50	Investigations of host-seeking behavior and hourly biting rhythm of malaria vectors in Chano Mille in southwest Ethiopia: an experimental study	Melkam Abiye
03:50-04:05	A Unique Plasmodium falciparum K13 Propeller Gene Mutation in Northwest Ethiopia	Abebe Genetu
04:05-04:20	Community Based Awarness Raising and Behavioral Change Communication to Reduce Malaria Burden in Amhara National Regional State	Akililu Getenet
04:20-05:00	**Discussion**	**Participants**
Day 2	
Session V: Malaria Prevention and Control Interventions Moderator: Ms. Hiwot Teka	
03:00-03:15	Understanding Malaria Endemicity in Ethiopia through Combined Application of Classical Methods and Enzyme Linked Immuno Assay: Implications for Countries with Different Disease Eco-Epidemiology Initiating Elimination Program	Zewdie Birhanu
03:15-09:30	Knowledge and perception towards net care and repair practice in Ethiopia	Honelgn Nahusenay
09:30-09:45	Rural households at risk of malaria did not own sufficient insecticide treated nets at Dabat HDSS site:	Kindie Fentahun

09:45-10:00	Factors associated with LLINs use in Ethiopia: Multilevel analysis of household survey data	Samir Awol
10:00-10:30	**Discussion**	**Participants**
10:30-11:00	**Tea break**	**Organizers**
Session VI: Malaria treatment/Clinical Pharmacology Moderator: Dr. Kebede Etana/Dr. Abebe Genetu		
11:00-11:15	Evaluation of essential oils extracted from native Ethiopian home garden plants against malarial vector Anopheles gambiae s.l. (Diptera: Culicidae)	Wondmeneh Jembere
11:15-11:30	Smoking local medicinal plants reduced indoor density of malaria vectors and inhibited feeding on host in southwest Ethiopia	Tekle Olbamo
11:30-11:45	Evaluation of Azadirachta indica A. Juss. and Schinus molle L seed and leaf extracts for larvicdal and growth regulation against Anopheles arabiensis Patton (Diptera: Culicidae) under laboratory conditions	Getnet Atenafu
11:45-12:00	Malaria Outbreak Investigation - Dilla Town, Southern Ethiopia, 2016	Abadi Belay
12:00-12:30	**Discussion**	**Participants**
12:30-01:30	**Lunch break**	**Organizers**
Session VII: Business meeting Moderator: Dr. Adugna Woyessa/Dr. Ayele Zewde		
1:30-03:00	Business meeting/ Discussion on Malaria research network future direction	Participants
03:00-03:30	**Tea break**	**Organizers**
03:30-04:30	Business meeting/ Discussion on Malaria research network future direction	Participants
04:30- 05:00	**Closing Remarks**	**FMoH/EPHI/ACIPH**

Abstracts for Poster presentation

1	Urban malaria transmission by Non - Anopheles gambiae complexes in Gondar Town	Wossenseged Lemma
2	Movement patterns of seasonal migrant workers associated with malaria risk derived from outpatient register books in Amhara Region, Ethiopia	PATH/MACEPA
3	SMART surveillance: An ODK-based Android app for malaria case investigation in Amhara National Regional State, Ethiopia	PATH/MACEPA
4	Malaria parasitemia and serological prevalence in near-zero transmission settings in Ethiopia	PATH/MACEPA
5	Movement patterns of seasonal migrant workers associated with malaria risk derived from outpatient register books in Amhara Region, Ethiopia.	PATH/MACEPA

Strengthening Malaria Monitoring and Evaluation Systems (SMMES)

The 9th Ethiopian Malaria Research Network Symposium

Abstract Booklet

28 – 29 November, 2017

Gondar, Ethiopia

Automated Diagnostic Platform, Data Management System and Innovative Communication Tool, for Improving the Impact of Malaria Vector Control Interventions in sub-Saharan Africa

DelenasawYewhalaw[1], Edward Thomsen[2], Kristen Duda[2], Claire Dormann[2], Michael Coleman[2], Kora Tushune[3], Evangelia Morou[4], John Vontas[4]

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The need to control insect vectors that carry human diseases is a complex and demanding topic which is directly related to human healthcare, especially in tropical regions such as sub-Saharan Africa, where malaria (and other) vectors infect millions of people annually. Moreover, the rising challenge of insecticide resistance has led to the failure of control programs which are now limited in the choice of tools available to them for control and elimination of disease.

The goal of the research project is to develop a fully automated diagnostic platform to monitor the species ID, the infection status of malaria vector populations as well as their insecticide resistance profile. We will use a microfluidic cartridge, the LabDisk, which integrates components for in situ DNA/RNA purification and amplification, and it is handled by a portable instrument that allows the simultaneous detection of multiplex targets. The LabDisk will be interfaced with a Disease Data Management System (DDMS), a system that assists with the monitoring of interventions and evaluation of vector control programme impact. Data entry, management and reporting from a variety of datasets have already shown benefit in several African countries. DDMS will integrate all crucial information for vector control, giving a more holistic view of the control programme, and it will be implemented in four sub-Saharan African countries, to support informed decision about vector control and disease management. An innovative communication and learning tool using serious gaming principles ("Serious GAME") will be explored to improve the communication of disease vector control management guidelines to end users. The overall research project goal is to develop and validate the enabling tools as part of the drive to optimize impact of vector control interventions and save more lives. The system is readily expandable to more vector borne diseases (such as Dengue and VL) and countries.

The Genie's LAMP: applications in malaria prevention and control for Ethiopia

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Malaria control has been hampered by the lack of a sensitive diagnostic method at the field level and the spectre of artemisinin resistance emerging in sub-Saharan Africa. Loop Mediated Isothermal Amplification (LAMP)-based methods have demonstrated remarkable potential at the health centre level at detecting low level malaria infections. LAMP can be performed without large capital equipment, with simple nucleic acid extractions, without electricity, and can be detected by the naked eye. Over the past 5 years, we have conducted both laboratory and field-based studies cementing the utility of LAMP-based methods. In the non-endemic setting, LAMP achieved 100% sensitivity in screening for malaria cases. These data suggest that LAMP may obviate the need for repeat microscopy and result in labour cost savings and provide a rapid, analytically sensitivity (LOD < 1 parasite/µL) result. In the endemic setting, we have effectively implemented LAMP at the health centre level, showing critical gains in sensitivity in key patient populations – the pregnant female and asymptomatic patients. While LAMP achieved 100% sensitivity in pregnant women, rapid diagnostic tests (RDTs) were 70% sensitive in our hands. We predict that additional gains in case detection afforded by LAMP will be essential in malaria elimination strategies. In an effort to further optimize LAMP, our laboratory has developed a reverse transcriptase (RT)-LAMP method which can detect *Plasmodium falciparum* up to 0.01 parasites/µL from culture spiked whole blood specimens, a cost-effective reference method for quality assurance in low middle income countries (LMICs). We have also developed a proprietary SNP-LAMP method which is 100% sensitive and 97.36% specific for identifying the C580Y mutation in the K13 propeller gene – the key mutations leading to artemisinin resistance in SE Asia. In this summative abstract, we will provide an overview of our work in the various aforementioned areas and a vision for the roadmap to eliminate malaria in Ethiopia.

Population Movement as a Risk Factor for Malaria Infection in High-Altitude Villages of Tahtay-Maychew District, Tigray, Northern Ethiopia: A Case-Control Study

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[4] Department of Medical Microbiology and Immunology, Institute of Biomedical Sciences, College of Health Sciences, Mekelle University, Mekelle, Ethiopia.

Background: Key goal and targets of the Ethiopia National Malaria Control Program are to achieve malaria elimination within specific geographical areas with historically low malaria transmission and to reach near-zero malaria transmission in the remaining malarious areas by 2020. However, back and forth population movement between high-transmission and low-transmission area imposes challenge on the success of national malaria control programs. Therefore, examining the effect of human movement and identification of at-risk populations is crucial in an elimination setting.

Methods: A matched case–control study was conducted among 520 study participants at a community level in low malaria transmission settings in northern Ethiopia. Study participants who received a malaria test were interviewed regarding their recent travel history. Bivariate and multivariate analyses were carried out to determine if the reported travel was related to malaria infection.

Results: Younger age (adjusted odds ratio [AOR] = 3.20, 95% confidence interval [CI]: 1.73, 5.89) and travel in the previous month (AOR = 11.40, 95% CI: 6.91, 18.82) were statistically significant risk factors for malaria infection. Other statistically significant factors, including lower educational level (AOR = 2.21, 95% CI: 1.26, 3.86) and nonagricultural in occupation (AOR = 2.0, 95% CI: 1.02, 3.94), were also found as risk factors for malaria infection.

Conclusions: Generally, travel history was found to be a strong predictor for malaria acquisition in the high-altitude villages. Therefore, besides the existing efforts in endemic areas, targeting those who frequently travel to malarious areas is crucial to reduce malaria infection risks and possibility of local transmissions in high-altitude areas of northern Ethiopia.

Five years malaria trend analysis of Woreta Health Center, Northwest Ethiopia

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Background: An estimated 68% of the Ethiopian population, living in 75% of the landmass, is at risk of contracting malaria at any time making it the leading public health problem in the country. The temporal analysis of malaria data on different health care systems could be important to evaluate the performance of malaria prevention programs. This study aimed to determine the trend of malaria at Woreta Health Center (WHC), Northwest Ethiopia over a period of five years.

Methods: We analyzed the records of 8,057 presumptive malaria cases registered at WHC in the period of 2012 to 2016. The following patient data were retrieved for analysis; sex, age, residence, blood film (BF) microscopy result, type of malaria parasite identified, year and month when the patients visited WHC. Patients were suspected for malaria when they presented with fever and related clinical symptoms. Data were retrieved directly from laboratory registration log book using prepared data extraction sheet. Data were entered, cleaned and analyzed using SPSS version 23 for windows. Stepwise logistic regression was employed to assess the association between potential predictors and malaria infection; p value < 0.05 was considered to be significant.

Results: Among the total suspected patients registered, 4447 (55.2%) were females. The median age of the patients was at 25.0 years. Of the participants 5062 (62.8%) and 6176 (76.7%) were from rural settings and in the age group >15 years, respectively. The prevalence of malaria in each year was ranged from 4.1% to 6.7%. The overall prevalence of malaria among suspected cases was at 5.4% (95%CI: 4.9%-5.9%). The two most important species of malaria parasite identified were *P. falciparum* at 233 (53.7%; 95%CI: 49%-58.3%) and *P. vivax* at 184 (42.4%; 95%CI: 37.8%-47.1%). Relatively higher proportions of cases were documented in the month of November, December and June at 11.1%, 8.1% and 7.2%, respectively. Patients who visited the health center in the month of December were >4 times more likely to be infected as compared with those who came to the health center in September [AOR: 4.2, 95%CI (2.374-7.560)]. Females were 1.3 times more likely to be infected than males, [AOR: 1.3, 95%CI (1.101-1.638)]. Similarly, patients in the age group above 15 were 1.9 times more likely to be infected than children < 5, [AOR: 1.9 95%CI (1.498-2.455), p value 0.000].

Conclusions: In the studied area, malaria remains as a major public health challenge. Hence, interventions to decrease the impact of the disease have to be evaluated and strengthened.

Key words: Malaria, trend analysis, Ethiopia

Malaria Surveillance System Evaluation in Ganta-Afeshum District, Tigray Region, Ethiopia, 2016: Challenges to malaria Elimination in Low transmission Area

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Background: Malaria is priority problem in Ethiopia with the highest public health concern in Tigray. It is endemic in Ganta-Afeshom District with recently experiencing an outbreak. As part of regional malaria control program evaluation, this study is intended to evaluate the existing malaria surveillance system in the district.

Methods: *Descriptive cross-sectional study* and retrospective document review was conducted on data of July 1, 2015 to June 30, 2016. We purposively selected four most malaria affected cluster health centers, and randomly selected six health posts within the health centers using proportional allocation. We collected data using *semi-structured questionnaires* by *interviews, observations and document-reviews*. Data was cleaned, entered and analyzed using *MS-Excel.*

Result: Reporting rate in the district was 77% during the year. There was no data analysis and interpretation. There was neither of epidemic preparedness and response plan, emergency stocks, or regular feed-back and supervision in the district. The system had detected 1073 confirmed malaria cases with no death. However, it delayed in detection and response of epidemics. The system was easy with willingness to continue in 82%; and flexible 100%. Data was only from public health facilities, and timeliness of the report was unknown. Report was complete in 82% of 11 sites. However, the system was not stable; and had low predictive value of positive test (46%). Lack of training and scarcity of surveillance resources were main problems.

Conclusion: Malaria surveillance system had limited usefulness in the district with unsatisfactory reporting, low data analysis, and delayed epidemic detection and response. Feed-back and supervision were not regular, and surveillance resources were scarce. The system was simple, flexible and acceptable; but neither representative nor stable; and had low positive predictive value. Efforts are needed towards improving regular supervision, feed-back, data analysis, allocating budget, and preparing emergency plans and stocks.

Keywords: Malaria, Surveillance Evaluation, Ganta-Afeshum, Tigray Region, Ethiopia

Reactive case detection for malaria in Amhara National Regional State, Ethiopia: Descriptive and impact evaluation analysis

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Case investigation (CI) of malaria cases and reactive case detection (RCD) of malaria infections are strategies that can contribute to malaria elimination in low-transmission settings. In Amhara region, Ethiopia, CI with RCD was conducted in 37 villages during the malaria transmission seasons in 2015–2016. *P. falciparum* or mixed malaria cases diagnosed at the health posts were considered index cases and were investigated (regarding socioeconomic characteristics, travel history, etc.). RCD with focal test and treat (FTAT) was conducted in the index case household and the ten closest neighboring households within a 100 meter radius. During the FTAT, all individuals in the targeted households were tested with a rapid diagnostic test (RDT) and all positives were treated with an antimalarial drug. Preliminary results from April 2015 to August 2016 indicate that there were 179 index cases, of which 47% were investigated. Of these, 58% were male and only 23% were children younger than ten years of age. During the FTAT, 548 households were visited, of which 96% were investigated. Of the 2,372 individuals in those households, 85% were tested, of which 1.7% were positive (56% *P. falciparum*, 18% *P. vivax*, 26% mixed). Risk factors for RDT-positivity included travel history, reported or measured fever, sleeping under a bed net, and recent antimalarial treatment. There were different transmission patterns, with several villages having very few cases, some villages having mostly imported cases, and others having mostly local cases. To evaluate whether CI with RCD had an impact on malaria incidence in the intervention villages, a quasi-experimental design with a comparison group of villages from the same regions—matched by pre-intervention incidence and altitude— will be used. A difference-in-differences analysis using negative binomial regression will be conducted. Final descriptive and impact evaluation results will be presented.

Physico-chemical and biological characterization of anopheline mosquito larval habitats (Diptera: Culicidae): implications for malaria control

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Background: A fundamental understanding of the spatial distribution and ecology of mosquito larvae is essential for effective vector control intervention strategies. In this study, data-driven decision tree models, generalized linear models and ordination analysis were used to identify the most important biotic and abiotic factors that affect the occurrence and abundance of mosquito larvae in Southwest Ethiopia.

Methods: In total, 220 samples were taken at 180 sampling locations during the years 2010 and 2012. Sampling sites were characterized based on physical, chemical and biological attributes. The predictive performance of decision tree models was evaluated based on correctly classified instances (CCI), Cohen's kappa statistic (κ) and the determination coefficient ($R2$). A conditional analysis was performed on the regression tree models to test the relation between key environmental and biological parameters and the abundance of mosquito larvae.

Results: The decision tree model developed for anopheline larvae showed a good model performance (CCI = 84 $\pm$ 2%, and κ = 0.66 $\pm$ 0.04), indicating that the genus has clear habitat requirements. Anopheline mosquito larvae showed a widespread distribution and especially occurred in small human-made aquatic habitats. Water temperature, canopy cover, emergent vegetation cover, and presence of predators and competitors were found to be the main variables determining the abundance and distribution of anopheline larvae. In contrast, anopheline mosquito larvae were found to be less prominently present in permanent larval habitats. This could be attributed to the high abundance and diversity of natural predators and competitors suppressing the mosquito population densities.

Conclusions: The findings of this study suggest that targeting smaller human-made aquatic habitats could result in effective larval control of anopheline mosquitoes in the study area. Controlling the occurrence of mosquito larvae via drainage of permanent wetlands may not be a good management strategy as it negatively affects the occurrence and abundance of mosquito predators and competitors and promotes an increase in anopheline population densities.

Keywords: Decision trees, Generalized linear model, Macroinvertebrate predators, Mosquito control, Mosquito larvae

Investigations of host-seeking behavior and hourly biting rhythm of malaria vectors in Chano Mille in southwest Ethiopia: an experimental study

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Introduction: The changing behaviors (early and outdoors biting) of malaria vectors in response to indoor based interventions remain as a key challenge for malaria control. Hence, understanding the host- seeking behavior and the peak biting hours of malaria vectors are vital in malaria vector control programs.

Method: This study assessed host-seeking behavior and hourly biting activity of malaria mosquitoes in Chano Mille village in southwest Ethiopia from October to December 2016. Field mosquito collection was done by human landing catches (HLC) in cattle baited tent (CBT), tent with human alone, and by keeping a cattle outside the tent at 1 meter. The peak biting hour of malaria vectors was also assessed inside the village. Two tents were randomly selected for human alone and two for cattle baited collections in the first night, and rotated to compensate the variation in location and collectors skill. *Anopheles* mosquitoes were identified based on morphology using a key. The sporozoite infectivity status of *An.pharoensis* (common species) was examined using Enzyme-Linked Immuno-Sorbent Assay technique. A Generalized Estimating Equations with a negative binomial distribution was used to see the impact of keeping cattle inside tent and outside in 1 m distance on human exposure to mosquito bites.

Result: Three Anophelines species (*An. pharoensis, An. gambiae* complex and *An. tenebrosus*) were identified. The presence of cattle with human inside the tent increased the number of *An. pharoensis* by 42% (p< 0.001) compared to human alone. Moreover, keeping cattle outside in 1 m distance from the tent also increased the number of *An. pharoensis* inside the tent by 46% (p= 0.002) than human tent with no cattle outside. The presence of cattle with human inside the tent and outside in 1 m distance has no significant effect on the host seeking activities of *An. gambiae* complex and *An. tenebrosus*. *An. pharoensis* and *An. gambiae* complex showed early night biting activity with peak biting from 19-20:00. It was highly significant for *An. pharoensis* (p= 0.015) and *An. gambiae* complex (p< 0.001) at 19-20:00 hour. Moreover, *An. gambiae* complex was mainly seeking hosts outdoors throughout the night in a village practicing indoor based interventions. No *An.pharoensis* were positive for *P. falciparum* and *P. vivax* infection.

Conclusions: Keeping cattle close to human increased the exposure to bites of malaria vectors particularly to the zoophilic malaria vector *An. pharoensis*. The outdoor biting behavior of the *An. gambiae* complex could be a threat for malaria vector control as well as elimination. Hence, it is also time to develop and implement tools to control the outdoor biting malaria vectors. Moreover, the deployment of cattle far from human residence could be recommended to reduce the human exposure to malaria vectors.

Keyword: Cattle baited collection, host-seeking behavior, hourly

A Unique *Plasmodium falciparum* K13 Propeller Gene Mutation in Northwest Ethiopia

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Background: Artemisinin combination therapy (ACT) is considered first-line to treat uncomplicated falciparum malaria worldwide. Recently, artemisinin resistance has emerged in Southeast Asia. Resistance to artemisinin has been shown to be highly associated with mutations on the propeller domain of *Plasmodium falciparum* K13 gene. The mutations identified in Southeast Asia have not been observed in Africa to-date. In this study, we aimed to investigate the presence of *P. falciparum* K13 propeller gene mutations from samples collected as part of the ACT clinical trial conducted in Northwest Ethiopia.

Methods: Confirmed falciparum malaria patients (n=148) in five districts in Northwest Ethiopia were enrolled in a 28-day ACT trial. Nested PCR for K13 propeller gene was performed on DNA samples extracted from filter paper blood spots. The PCR product was sequenced bi-directionally and the sequences were compared with the reference sequence of K13 gene (PF3D7_1343700). *Plasmodium falciparum* K13 propeller gene was amplified from genomic DNA isolated from 125 out of 148 blood samples collected from the five sites.

Results: We have found a unique mutation in K13 propeller domain (R622I) in 3/125 (2.4%) samples. The three isolates with R622I mutation came from Negade-Bahir and Aykel districts close to the Ethiopia-Sudan border. One of the three patients infected with the mutant strain had a day-3 positive result by microscopy. Homology modeling of the mutant protein indicates that the mutation is highly likely to disrupt the function of the protein.

Conclusions: The study has shown the emergence of a novel mutation on the propeller domain of the *P. falciparum* K13 gene in Northwest Ethiopia which is linked to day-3 positivity in a single patient but not treatment failure in a 28 day ACT trial. The mutation has not been previously reported in Asia and Africa.

Community Based Awareness (CBA) for Social and Behavioral Change Communication (SBCC) Project Terminal Evaluation

Health, Development and Anti-Malaria Association (HDAMA)

Community Based Awareness (CBA) for Social and Behavioral Change Communication (SBCC) Project was implemented in selected 5 Woredas located in Amhara National Region between 2013 and 2016, to promote social and behavioral change communication efforts through existing structures at community level to prevent and control malaria. Terminal evaluation was undertaken to measure changes associated with the project in the targeted areas. This measurement has done a comparative analysis on the changes observed from the baseline.

Both quantitative and qualitative methods were employed in the collection and analysis of data. Household survey was employed to collect quantitative data. A review of documents and available data on the project was also conducted. In addition to the Key Informants Interviews (KII) with project staff and implementing partners, Focus Group Discussion (FGD) with project beneficiaries targeted was held. An observation was also made to gather qualitative information substantiating the Household Survey, KII and FGD conducted.

The evaluation result revealed that community members' knowledge and attitude in the targeted areas about causes, mode of transmission, symptoms, preventative measures and treatment of malaria has been lifted significantly. One the other hand, there are still misconceptions on the mode of transmission of malaria. The knowledge and practice in relation to mosquito, such as breeding places and biting time shows an increase of 50.6% and 52.7% respectively, from the baseline survey result. There was a significant rise in the proportion of respondents who mentioned two symptoms related to the onset of malaria. The knowledge, attitude and practice in relation to ITN use and IRS as a prevention measure was grown to 98.6% and 75.1% respectively, grown by 17.2% and 64.7% respectively from the baseline. There was a negative change in the proportion of respondents who have indicated the practice of '*draining stagnant water*' as a preventative measure for malaria (38.9%), seeing a reduction by 2.6% from the baseline assessment result. There was also an increase in the number of households and individuals who have slept under an ITN in the previous night. Similarly, the rate pregnant women and children under the age of 5, who slept under ITN the previous night has shown a huge progress from the baseline and also compared to the general population. About 9.5% of the populations are without a vector control measure, calculated as the 'proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months from the time of the data collection was estimated to be 90.46%. Characteristics such as sex, level of education, place of

residence and availability of a family member attending formal education, responsibility of the individual within the community, participation in community conversations and trainings were determinant factors in the individual's knowledge, attitude and practice was noticeable. All respondents have the attitude that malaria is treatable in health facilities.

In sum, the project has contributed to the malaria prevention and control strategic plan of the country, both through increasing awareness on the causes, prevention and treatment, changing negative perceptions counter playing the efforts being made on preventing and treating malaria, increased the demand and proper use of LLIN and IRS being provided by the government. The project has also introduced good practices that can reinforce behavioural change at community level and increased participation of students in primary schools in project targeted Kebeles to promote adherence on practices that can prevent and control malaria.

Capitalizing on the opportunities around, also re-thinking to fully leverage from existing structures in place to maximize the impact in malaria prevention and control through community mobilization; addressing the misconceptions through continuous engagement in information, education and communication to bring and sustain behavioral change, identifying and implementing focused strategies for every groups of the community; and improving project management, stakeholders' engagement and quality control practices while implementing the current or similar projects are some of the major recommendation forwarded for consideration.

Understanding Malaria Endemicity in Ethiopia through Combined Application of Classical Methods and Enzyme Linked Immuno Assay: Implications for Countries with Different Disease Eco-Epidemiology Initiating Elimination Program

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Background: In the context of reduced transmission of malaria, it is essential to re-evaluate and determine the levels of endemicity as it guides re-orientation of control measures which is appropriate to local disease epidemiology. However, little is known about level of malaria transmission and endemicity in Ethiopia. This study quantified malaria endemicity through combined application of classical methods and Enzyme Linked Immuno Assay (EIA) in different malaria transmission settings of Ethiopia.

Methods: This study was conducted in June 2016 on 763 healthy children who were 2-9 years old. Children were recruited from ten sites representing different malaria transmission settings in Ethiopia. Splenomegaly rate, infection rate and EIA antibody test were used to determine endemicity levels.

Results: The overall prevalence of malaria parasitaemia was 2.49% (19/763) (95%CI: 1.38-3.59) and 2.36% (18/763) (95%CI: 1.28-3.44) by rapid diagnostic test (RDT) and microscopy, respectively. Using RDT, infection rate was 1.57% (12/763) and 1.18% (9/763) for *P. falciparum* and *P. vivax*, respectively. *P. falciparum* accounted for 52.63% (10/19) of the positive cases by RDT. The prevalence of Parasitaemia significantly varied by altitude and localities (p=0.001); the highest (5.8%, 18/313) in areas below 1500m above sea level. Overall, splenomegaly rate was 1.70% (13/763, 95%CI: 0.78-0.2.66), making the overall malaria transmission hypo-endemic. Infection rate was higher among males (2.7%, 11/405), but rate of splenomegaly was higher in females. In congruent with spleen rate and parasitaemia, EIA showed a higher level of cumulative exposure to malaria with localized and highly heterogeneous transmission. Overall, 18.75% (126/672, 95%CI: 15.79-21.71) of the children were positive for total malaria antibodies with significant variations with altitude (p=0.001) and age (p=0.003); the higher in areas of <1500m asl

(25.8%, 72/279) and children ≥5years (22.1%, 93/421). Additionally, rate of exposure was also higher among males (20.9%, 75/359).

Conclusions: The prevalence of parasitaemia is significant in the study community. Splenomegaly and parasitaemia are not good measures to show variations in the levels of malaria transmission. However, malaria antibody test indicated that malaria transmission involved multiple levels of endemicity with greater degree of heterogeneity and localized risks, suggesting the broader implications and usefulness of serological indicator to identify the different patterns of transmission which requires customized interventions based on local level risks in the context of elimination targets.

Key words: Malaria, Endemicity, splenomegaly, malaria antibody, malaria serology, malaria EIA, parasitaemia, Ethiopia

Knowledge and perception towards net care and repair practice in Ethiopia

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Meaza Demissie,   Hanna Gulema,   Gunawardena Dissanayake,   Sheleme Chibsa,   Hiwot Solomon,
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Background: Long-lasting insecticidal nets (LLINs) are a key malaria control intervention. Although LLINs are presumed to be effective for 3 years under field or programmatic conditions, net care and repair approaches by users influence the physical and chemical durability. Understanding how knowledge, perception and practices influence net care and repair practices could guide the development of targeted behavioural change communication interventions related to net care and repair in Ethiopia and elsewhere.

Methods: This population-based, household survey was conducted in four regions of Ethiopia [Amhara, Oromia, Tigray, Southern Nations Nationalities Peoples Region (SNNPR)] in June 2015. A total of 1839 households were selected using multi-stage sampling procedures. The household respondents were the heads of households. A questionnaire was administered and the data were captured electronically. STATA software version 12 was used to analyse the data. Survey commands were used to account for the multi-stage sampling approach. Household descriptive statistics related to characteristics and levels of knowledge and perception on net care and repair are presented. Ordinal logistic regression was used to identify factors associated with net care and repair perceptions.

Results: Less than a quarter of the respondents (22.3%: 95% CI 20.4–24.3%) reported adequate knowledge of net care and repair; 24.6% (95% CI 22.7–26.5%) of the respondents reported receiving information on net care and repair in the previous 6 months. Thirty-five per cent of the respondents (35.1%: 95% CI 32.9–37.4%) reported positive perceptions towards net care and repair. Respondents with adequate knowledge on net care and repair (AOR 1.58: 95% CI 1.2–2.02), and those who discussed net care and repair with their family (AOR 1.47: 95% CI 1.14–1.89) had higher odds of having positive perceptions towards net care and repair.

Conclusions: The low level of reported knowledge on net care and repair, as well as the low level of reported positive perception towards net repair need to be addressed. Targeted behavioural change communication campaigns could be used to target specific groups; increased net care and repair would lead to longer lasting nets.

Keywords: Net care and repair, Knowledge, Perception, LLIN Ethiopia

Rural households at risk of malaria did not own sufficient insecticide treated nets at Dabat HDSS site: Evidence from a cross sectional re-census

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Background: Malaria is the leading cause of disease burden across the world, especially in African countries. Ethiopia has designed a five year (2011-2015) plan to cover 100% of the households in malarious areas with one insecticide treated net (ITN) for every two persons, and to raise consistent ITN utilization to at least 80%. However, evidence on ownership of ITN among malarious rural households in northwest Ethiopia is quite limited. Hence, the present study aimed at assessing ownership of ITN and associated factors among rural households at risk of malaria at Dabat Health and Demographic Surveillance System site, northwest Ethiopia.

Methods: A cross sectional re-census was carried out in Dabat Health and Demographic Surveillance System site during peak malaria seasons from October to December, 2014. Data for 15,088 households at Dabat Health and Demographic Surveillance System site were used for the analysis. Descriptive measures and binary logistic regression were carried out.

Results: Among those who owned at least one ITN, 53.4% were living at an altitude >2500 meters above sea level. However, out of households living at an altitude <2000 meters above sea level, 15.8% (95% CI 14.4%, 17.3%) owned ITN at an average of 4.3±2.1 persons per ITN. Of these, 69.5% (95% CI 64.7%, 74.1%) used the ITN. Among utilizing households at malarious areas, 14.2% prioritized pregnant women and 18.8% children to use ITN. The availability of radio receiver/mobile (AOR 1.60, 95%CI 1.08, 2.35) and secondary/above educational status of household member (AOR 1.54, 95%CI 1.19, 2.04) were predictors of ownership of ITN.

Conclusion: Rural households at risk of malaria did not own a sufficient number of ITN though the utilization is promising. Moreover, prioritizing children and pregnant women to sleep under ITN remains public health problems. Programmers, partners and implementers should consider tailored intervention strategy stratified by altitude in distributing ITN. ITN distribution should also be accompanied by using exhaustive promotion strategies that consider people without access to any source of information, and educating households to prioritize pregnant and under five children to sleep under ITN.

Keywords: Altitude, Determinants, ITN, Ownership, Utilization, Dabat, HDSS, northwest Ethiopia

Factors Associated with LLINs use in Ethiopia: Multilevel Analysis of Household Survey Data

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Background: The Long Lasting Insecticidal Nets (LLINs) are the most widely used malaria control interventions. According to the 2015 Ethiopia Malaria Indicator Survey, 38% of these households slept under the net the night before the survey, with varying levels of net ownership and utilization across regions in Ethiopia. Therefore, the purpose of this study was to determine both household and community level factors that are associated with LLINs use in Ethiopia.

Methods: The data source used in this study was the 2015 population-based, cross-sectional household survey conducted in four regions of Ethiopia [Amhara, Oromia, Tigray, and Southern Nations Nationalities Peoples Region]. Multilevel regression analysis techniques were used to conduct the analysis. Accordingly, a two level multilevel regression analysis model was built with 1839 households (level 1) nested with in 92 communities (level 2). STATA software version 13 was used to analyze the data with xtmelogit command.

Results: Nearly, 43 % of households have slept under LLINs the night before survey. At household and contextual levels; Household socio economic status, Age of the respondent, Number of LLINs owned by the household, receiving an information about net care and repair and geographic region were significantly associated with LLINs utilization. The analysis showed 28% of the variation in LLINs use among clusters was due to unmeasured factors operating at this level.

Conclusion: It was found that individual and contextual factors were associated with LLINs Utilization. In addition, significant community level variation remains after having controlled individual and community level factors which is an indicative of a need for further research on community level factors.

Key Words: LLINs, Multilevel, Ethiopia, households, community, contextual

Evaluation of essential oils extracted from native Ethiopian home garden plants against malarial vector *Anopheles gambiae s.l.* (Diptera: Culicidae)

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Background: Mosquitoes are perilously nuisance for human welfare due to transmission of life threatening malarial parasites. *Anopheles gambiae* is one of the important mosquitoes species transmitting causal organism of malaria in several part of Ethiopia. Eco-friendly alternative strategies are currently focussing area of research in vector control program. The aim of the study was to evaluate essential oils extracted from certain home garden plants against immature and adult malarial vector mosquito species *Anopheles gamabiae*.

Methods: Home garden plants such as *Lepidium sativum, Millitia ferruginea* and *Phytolacca dodecandra* seeds were collected in and around Gondar and subjected to clevanger apparatus to extract essential oil and tested against *An. gambiae*. The efficacy of essential oil was tested at different concentration against early and late instar larvae, pupae and 3-5 days old *An. gambiae* under laboratory condition by following World Health Organization recommended protocol.

Results: The percentage mortality of early, late instar larvae and pupae of *An. gambiae* exposed to *L. sativum* essential oil was 97, 91 and 99% respectively. The early instar larva and pupa exposed at 100 ppm concentration of *M. ferruginea* oil after 72hr exposure period 100% mortality was recorded. The time recorded for knock-down effect of 50% (KT_{50}) of adults mosquitoes exposed to 10% concentration of *L. sativum* and *M. ferruginea* was 10.05 ± 0.5 and 7.34 ± 0.2 min. respectively. The female adult mosquitoes exposed to 10 ppm concentration of *L. sativum* and *M. ferrugina* oil extract after 24 hr exposure period showed 82.66 and 95.66% mortality respectively.

Conclusion and recommendation: These two plant essential oil contains toxic secondary metabolites to kill immature and adult *An. gambiae* mosquitoes. However, in order to validate laboratory findings in the field appropriate formulation of essential oil is important to apply on breeding sites and indoor residual spray to control malaria vector, *An. gambiae*.

Key words/phrase: *Anopheles gambiae,* essential oil, knockdown, toxicity.

Smoking local medicinal plants reduced indoor density of malaria vectors and inhibited feeding on host in southwest Ethiopia

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Background: This study aimed to evaluate the impact of smoking *Juniperus procera, Eucalyptus globulus* and *Olea europaea* on indoor density and feeding activity of malaria vectors in Kolla Shara village, southwest Ethiopia.

Methods: Five grass thatched traditional huts were selected for the field trial. Tent experiments were conducted to evaluate the effect of smoking leaves/seeds of the above plants on feeding activities malaria mosquitoes. A Latin square design was employed to minimize the bias due to the variation in house location and different sampling nights in field trial. We used wild *Anopheles* mosquitoes for tent experiments. The larvae of *Anopheles* mosquitoes were collected and reared into adults to release into tents where a calf was tethered in each tent. *Anopheles* mosquito larvae and pupae were collected from natural breeding habitats in the village and reared into adults for the tent experiment. Twenty adult *An. gambiae* complex (*An. arabiensis*) were released into each tent to evaluate the effect of smoking plants on feeding activities.

Results: *Anopheles arabiensis, An. demeilloni, An. funestus*-group*, An. pretoriensis* and *An. pharoensis* were documented in the field collection. *Juniperusprocera, E. globulus* and *O. europea* significantly reduced indoor density of *Anopheles arabiensis* with mean percentage reduction of 80%, 73% and 70% respectively compared to the control. In the tent trial, smoking plants significantly inhibited feeding on calf (F = 383.5, DF = 3, p< 0.01) and has induced knockdown effects. The mean feeding inhibition was relatively higher due to *Olea europaea* (18.9±0.24) followed by *E. globulus* (17.9±0.37) and *J. procera* (17.2±0.34), while it was 3.9±0.42 in control tents without plant smoke.

Conclusion: smoking *J. procera, E. globulus* and *O. europea* had significant effect on indoor density of host seeking malaria vectors and have inhibited feeding in the tent trials. Therefore, plant-based mosquito control may play role in reducing mosquito biting at early hours and thereby reduce malaria transmission. However, further study is recommended for isolation and identification of bio-active molecules of these test plants and their mode of action to prepare products that could be commercialized and used as potent supplementary control options. **Key words/phrases:** Feeding inhibition, indoor density, Kolla Shara medicinal plants*,* smoking plants

Evaluation of *Azadirachta indica* A. Juss. and *Schinus molle* L seed and leaf extracts for larvicdal and growth regulation against *Anopheles arabiensis* Patton (Diptera: Culicidae) under laboratory conditions

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Background: The resistance of mosquitoes to chemical insecticides and the concern for environmental safety leads to promotions in search of plant extracts for larvicide activities. The aim of the present study was, therefore to evaluate larvicidal and growth inhibition effect of *Azadirachta indica* and *Schinus molle* seed and leaves extracts against the 2nd and 4th instar larvae of *Anopheles arabiensis* Patton of strain I and II in the laboratory.

Methods: Solvents for extraction were ethanol, chloroform, and water. Distilled water was used as control. Percent mortalities, LC_{50} and LC_{90} values were determined after 24 hr exposure. The length of the developmental stages and total development periods against 2nd instar *An. arabensis* larvae using ethanol and aqueous extracts of seed has been evaluated.

Results: More than 90% death was recorded by seed extracts in all laboratory strain I and II at 200 ppm within 24 hr. Based on the Probit analysis, LC_{50} values of seed extracted by chloroform and water was less than 100 ppm in both strains I and II. The standard larvicide, Abate, killed all the specimens within 6 hrs.

Conclusions: Larval growth index (LGI) and percent pupation results showed that both ethanol and aqueous extracts (10, 20 ppm) reduce the number of larvae that survived to pupal stage and adult emergence extended up to 10 days as compared to the other treatments and the controls. We infer that application of these extracts to larval habitats may lead to promising results in malaria vector mosquito management strategies.

Key words: *Anopheles arabiensis, Azadirachata indica, Schinus molle,* larvicidal activity, growth inhibition, plant extracts.