The 8th Malaria Research Symposium

Feb 27—28, 2017, Addis Ababa

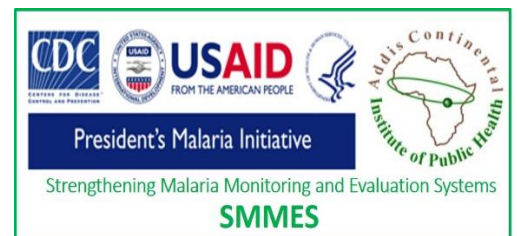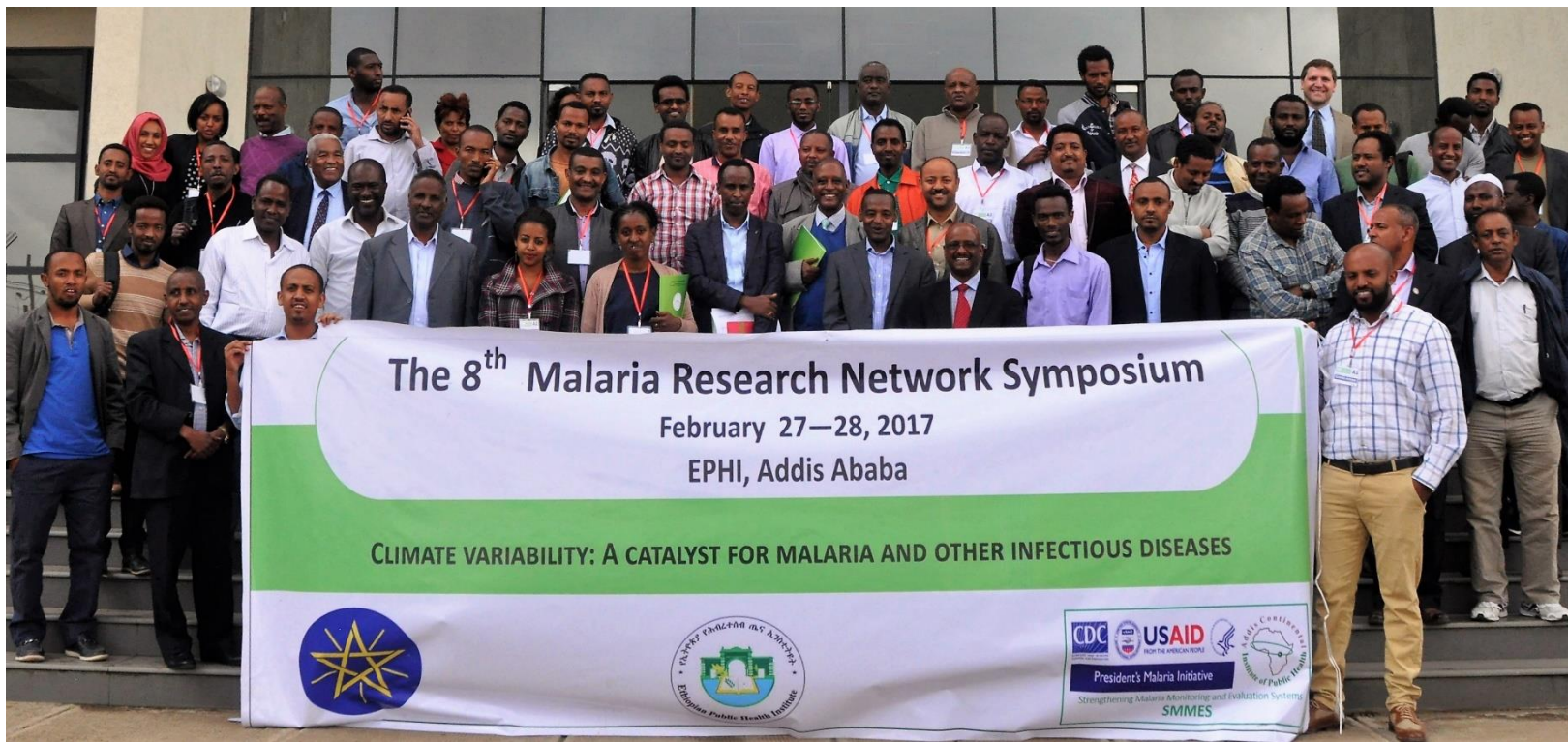# Proceedings

The 8th Malaria Research Network Symposium
February 27—28, 2017
EPHI, Addis Ababa

CLIMATE VARIABILITY: A CATALYST FOR MALARIA AND OTHER INFECTIOUS DISEASES

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Acronyms

AAU	Addis Ababa University
ACIPH	Addis Continental Institute of Public Health
ACPR	Adequate Parasitological and Clinical Response
ACTs	Artemesinin Combination Therapies
AIDS	Acquired Immuno Deficiency Syndrome
AL	Artemether-Lumefantrine
ALIPB	Aklilu Lema Institute of Patho Biology
AMU	Arba Minch University
CDC	Centre for Disease Control
CI	Confidence Interval
CQ	Chloroquine
CQS	Chloroquine Sensitive Strain
DBS	Dried Blood Spot
DDT	Dichlorodiphenyltrichloroethane
EAs	Enumeration Areas
ELISA	Enzyme-linked Immunosorbent Assays
ENSO	El-Nino Southern Oscillation
ENACTS	**Enhanced National Climate Services**
EPHI	Ethiopian Public Health Institute
FMOH	Federal Ministry of Health
GPS	Global Positioning System
HDAs	Health Development Armies
HEWs	Health Extension Workers
HF	Health Facility
HHs	House Holds
HLC	Human Landing Catches
HMIS	Health Management Information System
ICAP	International Center for AIDS Care and Treatment Program
IIRS	Indoor Residual Spray
ITNs	Insecticide Treated Nets
JU	Jimma University
LBW	Low Birth Weight

LLCF	Late Clinical Failure
LLINs	Long Lasting Insecticide Treated Nets
LQAS	Lots Quality Assurance Survey
MC	Malaria Consortium
MIS	Malaria Indicator Survey
MRN	Malaria Research Network
MTT	Methyl-Thiazol Tetrazolium
NGO	Non-Governmental Organization
ODK	Open Data Kit
OR	Odds Ratio
PCR	Polymerase Chain Reaction
PCV	Packed Cell Volume
PHEM	Public Health Emergency Management
PMI	President's Malaria Initiative
PPM	Public Private Mix
PSCs	Pyrethrum Spray Catches
PTD	Preterm delivery
RDT	Rapid Diagnostic Test
RHB	Regional Health Bureaus
SD	Standard Deviation
SHOPS	Strengthening Health Outcomes through the Private Sectors
SMMES:	Strengthening Malaria Monitoring and Evaluation Systems of Ethiopia
SPSS	Statistical Package for Social Sciences
STATA	Data Analysis and Statistical Software
TB	Tuberculosis
TIDRC	Tropical and Infectious Disease Research Centre
USAID	United States Agency for International Aid
WHO	World Health Organization

Day 1: Feb 27, 2017

Session I: Welcome and Introductory Remark

Welcome speech was made by Dr. Adugna Woyesa, the Chairperson of Ethiopian malaria Research Network. He welcomed all the participants to EPHI and for Malaria Research Symposium. Mentioning that EPHI is almost two years old now with its new mandate, as Chairperson representing the Public health Institute, he reminded that the institute has revolved through some organizational changes and it is still serving the nation almost for four to five decades. He then reminded that currently the institute is having a number of discussions to serve the nation in more advanced way. He also mentioned the three thematic areas the institute is engaged in; research for action, Public health emergency management and laboratory quality system.

He also mentioned that the new training center built by the institute is one of the crosscutting component which is believed to be a mean to serve in building the capacity of the work force in the health sector and other collaborating institutions.

He then reminded that currently the institute has got one full time coordinator to lead this network since January and expressed his hope about the bright futurity of the network under the coordinator.

Mentioning that EPHI is hosting this Malaria research network symposium for its first time, the research network for which the institute has been chairperson since 2014 when it was voted to chair during Malaria Research Network at Mekelle University, he again welcomed the participants to EPHI and for this Symposium.

He also expressed his wish that this symposium will have a session on how to advance the role of this network and finally he thanked the coordinators, the organizers for making this symposium ready in few week time. He thanked Dr. Wodatir and the whole Addis Continental Institute of Public Health's staffs for their commitment in organizing this symposium while they were still very busy with other activities.

Following Dr. Adugna's speech, Dr. Matt Murphy, on behalf of PMI, made his speech. Thanking everybody for the chance, he acknowledged the progresses that have been made in Ethiopia due to contributions made for medical agencies, organizations and universities. He also appreciated the news being heard from researchers and public officials that Ethiopia is planning for Malaria elimination which shows the improvements made in decreasing the infection.

He then reminded that we must continue strengthening the partnerships and collaborations with public and individual organizations to make evidence based malaria control strategies. He acknowledged the generation of evidences that helped decision makers to identify the gaps, best practices and use the potentially available malaria control technologies. Explaining that he is very excited to be here with so many people doing different types of researches and other works, he pointed out that the next days which will be focusing on the climate and malaria will remind all to face the fact that the future may have different situations.

He also explained that, with the role these team have in Ethiopian community as researchers, we can work together to understand the cause of the climate change and the impact of infectious diseases piece by piece into ever firm grasp on the thought picture.

Thanking EPHI, MOH and the organizers of the Malaria Research Network Symposium for their effort organizing this symposium for the attendees, he ended his speech by reminding that we can make the today pass and tomorrow pass have so many discussions about issues related to malaria and other infectious diseases.

Following Dr. Matt's speech, Dr. Ayele Zewdie, SMMES Project Chief of Party, made speech on behalf of Addis Continental Institute of Public health, SMMES project. He said that it is great honor and privilege for him to address this key note representing Addis Continental Institute of Public health in general and Strengthening Malaria Monitoring and Evaluation System project in particular. He then mentioned that Addis Continental Institute of Public health has got two good reasons to support the Malaria Research Network of Ethiopia. The first reason is that Addis Continental Institute of Public health is public health institute aspiring to be a center of excellence in public health; therefore the institute has an inherent desire to strengthen such like research related activities. The second reason is strengthening malaria research network is one of the planned activity under one of the aims of the Strengthening Malaria Monitoring and Evaluation System project.

He then reminded that Malaria research network was established under the leadership of PMI in 2010 and since then, the symposiums were being organized in collaboration with local universities with the aim of benefiting the students and the members working at universities. He also mentioned that since 2014, EPHI is serving as chairperson of the network and ACIPH as the secretariat of the network. Giving the definition of the term 'network', he assured that the organization of the symposium, at least once in a year, will create the forum for researchers to gather and share ideas and information through this network.

He also stressed the main reason for the establishment of the network, which was due to identification of a significant long standing gap between production of malaria researches and outcomes by researchers and use of its findings by practitioners, policy makers and organizations involved in malaria prevention and control. This gap was again identified during stakeholders meeting that was organized by FMOH, RBM and ACIPH in November 2014 and even during the recent malaria program reviewing by external evaluators.

He also mentioned that at different occasions, members of the network have indicated to see network be the body that generates its own income even to grow to an independent professional association with a goal to make malaria research available for use by policy makers and program leaders for malaria prevention, control and elimination from Ethiopia.

He said, "We all have started to play the game well but not scored a goal yet. We have to work hard to score the goal which is the key to win the game".

Finally, on behalf of Malaria Research network and ACIPH, he thanked FMOH and EPHI for their unreserved support in strengthening Malaria research network, the national meteorology agency for responding to the short notice to present on 'Climate and health' topic. Also PMI and all PMI team for the generous financial support they are providing in the malaria prevention and control of Ethiopia. Lastly, he appreciated the participation of malaria

researchers for being with the team and making the symposiums colorful and, more, the participants who are made the symposium complete.

Following Dr Ayele's speech, Dr Eba Abate, Director General of EPHI, made the opening speech. Dr Eba warmly welcomed all the participants to the symposium. He then mentioned that having such like network could serve the nation as a bridge to address the gap of lack of coordination in sharing information among the people working in programmatic areas, researchers, academic institutions and other partners. Taking the opportunity, he congratulated the actors who played their role in establishing this magnificent network and who made it alive. He reminded that the first health center in Ethiopia was established in a small place at Kola Deba, 40km away from Gondar due to the death of more than 20,000 inhabitants from malaria epidemic. Still for years malaria has remained on of the public health important disease in Ethiopia but currently due to collaborative effort from different actors working in the area including the strong commitment given form government side, by well drafted preventive strategies, huge improvement has been achieved and the burden of malaria and its epidemic are significantly reduced. It is because of this achievement that the country is now to officially launch nationwide malaria elimination. The pleasant news we are hearing related to therapeutics and vaccine processes will augment the process of this initiative. However, he stressed that it very important to emphasize the need to strengthen further the efforts in all directions related with humans, vector control, and the environmental aspects and use the available findings in a comprehensive approach to achieve the set goal. And such scientific gatherings will help to share information among the researchers and others working in the area with better solution to support program activities.

Finally assuring that EPHI, as a technical arm of FMOH, will continue supporting the network and all the activities of the initiative with all its capacity, he declared that the symposium is officially opened.

Session II: Malaria and climate

This session was moderated by Dr Wakgarii Deressa. He invited the presenters of the session and the presentation was continued. The topics presented during this session were:

1. Climate sensitive disease early warning Practices, methodology and available tools at NMA by Mr. Henok Hailu,
2. Malaria elimination climate surveillance suite by Dr. Adugna Woyesa,
3. Repeated and seasonal survey highlights dominance of plasmodium vivax in Ethiopian highland by Dr Adugna Woyesa and
4. Preliminary result of the third Malaria Indicator Survey by Mr. Ashenafi Aseffa.

After all completed their presentations, the presenters were invited to take seats in front of the participants and questions were raised for them.

The questions raised for the presenters and their responses were mentioned below:

✓ **Questions are raised on Mr. Henock's presentation but due to urgent issue from his office, he left the session earlier. On behalf of him, Mr. Metekia Menza, from NMA, responded and the responses are summarized as follows.**

He was asked that it seems the meteorology agency mostly focused on meteorological variables like temperature, humidity and rainfall only; but not land management and the vegetation coverage, he replied the agency cannot cover all parts of the indicators across the country due to expensiveness of the first class stations. So, the agency uses the strategy of touching the main points according to the topography so that it can go through the important variables. Other than the temperature, humidity and rainfall, he replied that they are not considering because they don't have the mandate to do that.

He was also asked if the raw data /climate variable data/ are really accessible so that researches can be done in the areas of interest by researchers; and also he was asked data dissemination mechanism of the agency. He replied that the data is accessible but the data is not available online. He reminded any interested body can formally go to the agency and get the data.

He was also asked how precise is the forecast to predict climate related diseases like malaria and he replied that it is difficult to say the data are perfect because there are some variables left unseen which might are creating favorable environments for malaria transmission. He added that there is plan to study what is going on in this regard.

He was again asked how is working relationship between National Meteorology Agency and other institutions in making use of climate data and he replied that there is relation between the agency and other organizations. He added that currently there is a plan to link with the stakeholders so that there will be data interaction, weather information sharing and use between the main stakeholder.

Asked if the researcher had considered species variation in predicting malaria because there are arguments that *P.falciparumalciparum* is the most important species in predicting malaria than climate, he replied that he didn't.

✓ **Questions raised on Dr. Adugna's presentation and his responses:**

He was asked why Elnino is for widespread epidemic and LaNina is for local epidemic and what he mean by widespread epidemic and local epidemic, he replied regarding to local widespread epidemic and local epidemic issue, when we say local widespread epidemic we mean that there are epidemics in most of the places which have more or less similar (higher) altitudes. When we say local epidemic, we mean that only some of the areas were affected by epidemics including those which were malaria free before (above 2000 masl).

For the reason for epidemic during Elnino, which is supposed to be dry period, he admitted that as indicated in literatures, humidity, rainfall and temperatures are the main factors for malaria epidemic and this is true under the ideal conditions only. When there is Elnino, the mosquitoes continue to lay their eggs but there will be no rain which can wash away the eggs and interrupt the growth progress of the egg. Here, the rivers and streams remain as a pockets for the breading site of the mosquito. That is why the dry season can also be responsible for malaria epidemic during weather disturbances like Elnino because it will enable the mosquitoes to breed fast.

He was asked how the practical utility of the makes of malaria elimination from Ethiopia is and he replied, from the research side there some tools which are available and there is a push for these tools to be used. But we are on the start but no at the end of the stage with the job.

On the question raised regarding to the logic behind the dominance of *P.vivaxivax* malaria in the highlands of Ethiopia, and possibility of association between climate variability and the increasing dominance of *P.vivaxivax*, he replied that he thinks it the biological advantage that *P.vivaxivax* has had helped this species to progress to this level. One of the advantage is that the gametocyte stage of the infection occurs at the same time when the blood stage is occurring unlike *P.falciparumalciparum* whose gametocyte stage occurs after some weeks of infection. So, in case of *P.vivaxivax*, when a mosquito bites, it sucks the infective stage of the malaria parasite which increases the transmissibility of the species. The other advantage is about the dormant stage of the species which also increases its transmissibility. That is why we usually experience *P.vivaxivax* dominance including the highlands.

He was also asked about Ethiopia's the strategy to eliminate malaria from low transmission districts; whether this climate variability has been considered in identifying these low transmission districts, he replied that it was considered completely.

Regarding to the controversy between malaria decrement as a whole and the occurrence in highlands where there was no malaria before, he replied that the game is with the climate. The climate played key role for the event. Also, as some researches show, there is also imports of cases from lowland to highlands due to migration of population for many reasons.

✓ **Questions raised on Mr. Ashenafi's presentation and his responses:**

He was asked if the raw data of this MIS survey can be accessed just like DHS so that Masters and PhD students will get the chance to conduct their researches by using the data, he replied that he personally believe and support the idea (that the raw data have to be accessed and used)

but the data is not accessible like DHS because the finding should be published first. But he reminded that EPHI is considering some data sharing codes which will be implemented in the future.

Asked for clarification behind the LLIN and IRS coverage decrement during this 2015 MIS, he replied that from the FMOH side, the explanations for IRS coverage decline is the targeting reason (not many places are IRS targeted). For LLIN utilization also, the timing of LLIN replacement and the timing of the survey was mismatched (the survey is conducted before replacement). He added that there is survey/study currently ongoing to fill the gap.

He was also asked how the team saw this preliminary finding. He was asked for clarification why there is low prevalence of malaria despite low LLIN utilization. He replied, probably, the other interventions have contributed for the decline in malaria burden. Especially, the use of ACT which is gametocidal and which is available at all levels of the treatment setups across the country. He also added that other interventions like environmental management and other vector control methods might have contributed.

Asked about the mesh up in percentage coverage of some of the indicators among regions, especially in Amhara region, he replied that the team didn't go through the detail to check what the reason is.

On the similarity in timing and study area of the last three MIS' he replied more or less the timing and the coverage of the MIS data collection are similar and assured that we can compare the MIS' with each other.

Session III: Malaria and climate

This session was moderated by Professor Ahmed Ali. He invited the presenters of the session and the presentation was continued. The topics presented during this session were:

1. Assessment of Climate variability on the episode and spread of malaria over Ethiopia by Mr. Metekiya Menza,
2. Variation in species composition and infection rate of Anopheles mosquitoes at different altitudinal transects and the risk of malaria in the highland of Dirashe woreda, South Ethiopia by Mr. Taye Yohannes,
3. Comparative epidemiological study on ecology and behavior of anopheles mosquitoes in the highland and lowlands of Dirashe woreda, South Ethiopia by Terefe Gone and
4. Distribution of monthly pneumonia case correlated with climatic zone in Tigray region: ecological study, by Mr. Mulubirhan Assefa.

After all completed their presentations, the presenters were invited to take seats in front of the participants and questions were raised for them.

The questions raised for the presenters and their responses were mentioned below:

✓ **Questions raised on Mr. Metekiya Menza's presentation and his responses:**

He was asked if the spatial variation or relationship between the climate and malaria was tested to check whether it is statistically significant or not, he replied it wasn't done that way and took this as recommendation so that it can be considered for the future.

He was also asked if he had tried to see the association between malaria transmission season and the actual occurrence of malaria, he again replied that he didn't. But he said that for the spatial distribution of malaria vulnerability map: he used 108 stations where one can get malaria indicators one by one from the meteorological data.

✓ **Questions raised on Mr. Taye's presentation and his responses:**

He was asked why he concluded there is high malaria density in January. He was asked whether there are any permanent or temporary water sources in that area, and he replied there is a stream crossing the area of our study and most probably this has contributed in occurrence malaria cases during January.

He was asked to give clarification for that he stated altitude above 2060masl as high altitude and malaria in this area had somewhat high percentage. He was asked for source of the data; whether it is HF data or population data or data from other source and he replied the source he used is secondary data from Health posts and health centers.

✓ **Questions raised on Mr. Terefe's presentation and his responses:**

Mr. Terefe was asked about the reliability the method he used to check the of sporozoite infection rate and he replied the method he used was ELISA. He admitted that he didn't

included this in the limitation part because ELISA is not as specific as PCR but he reminded even though ELISA is not as such specific as PCR, still we can use the method.

Regarding to mentioning altitude above 2000 masl, he said it somewhat midland but didn't put this as a concrete highland.

✓ **Questions raised on Mr. Mulubirhan Assefa's presentation and his responses:**

He was asked how the team used to diagnose pneumonia because there can be confusions in differentiating URTIs and pneumonia especially at lower health facility level. He replied that the team had a pediatrician in the team during conducting this research and in addition to that there is IMNCI guideline which is so easy and very leading one in diagnosing most of the diseases occurring during childhood including pneumonia.

He was also asked about stating "four seasons in Ethiopia" which is different from what known from literatures; the literatures tell us that there are three. He said that this issue was one of the concerns which raised hot debate among the research team and finally the team reached on consensus to ask elders to know the seasons and accordingly they are told that there are four seasons: Autumn, winter, summer and spring.

Asked whether the team have tried to see malnutrition rate when they did the research, he admitted they didn't. And he added that they will take this as a chance to see the association between pneumonia and malnutrition, even to see which of the two comes first.

Also asked if the team had checked the immunization coverage in the area of your research, he replied that this is not considered in this specific resaerch but the University (Mekelle University) has one project on that area and the project is covering those issues in detail.

Commented the team had better include the issue of building immunity in your recommendation, he gladly accepted the recommendation.

Session IV: Malaria Entomology

This session was moderated by Dr Mekonnen Yohannes. He invited the presenters of the session and the presentation was continued. The topics presented during this session were:

1. Entomologic investigations on *Anopheles arabeinsis* and Plasmodium species infection prevalence in seasonal migrant and non-permanent laborers in extra-domestic agricultural field of Metema Armachiho lowlands, Northwest Ethiopia Dr. Wossenseged Lemma,
2. Efficient attractants and simple odor-biated sticky trap for surveillance of *Anopheles arabeinsis* patton mosquito in Ethiopia by Mr. Dawit Hawaria,
3. Entomological indicators of malaria transmission, insecticide susceptibility status of *Anopheles arabeinsis* in Sille village, Southwest Ethiopia by Mr. Misrak Abraham and
4. Zoo-prophylaxis as malaria control strategy for Anopheles arabeinsis: a systematic review by Dr. Abebe Asale

After all completed their presentations, the presenters were invited to take seats in front of the participants and questions were raised for them.

The questions raised for the presenters and their responses were mentioned below:

✓ **Questions raised on Dr. Wossenseged's presentation and his responses:**

He was asked for the main message he wanted to tell the participants, he replied he didn't finish his presentation due to poor time management, and he briefly responded for the message. He said when we look at lowland areas, interventions are not being conducted including no bed-net distribution and IRS. Therefore, we are trying to give evidence for high malaria transmission areas, especially for outdoor biting which is contributor for outdoor transmission. If possible, we are trying to suggest outdoor spray to enhance vector control in addition to the indoor spray, environment management and LLIN use.

✓ **Questions raised on Dr. Abebe Asale's presentation and his responses:**

Commented he had better linked the research with the current practices in using zoo-prophylaxis as malaria control strategy and he accepted this for consideration.

He was asked for the main aim of conducting this research and for his conclusion based on based on this systematic review, he replied that the idea of zoo-prophylaxis is not new but sidelined because of the other more effective vector control interventions the country is using but, mosquitoes are challenging some of the interventions. He said that this is why he wanted to search for other intervention which can support the already available interventions. He reminded that in most parts of the country, people live in the same house with their cattle and other livestock. Mosquitoes prefer to feed on cattle. So, when the mosquitoes come to feed on cattle, the cattle defends themselves. Therefore, they end up in biting human being. Thus, if we know this information (of their preference), we can search for intervention. He ended his response by reminding that this is why he wanted to contribute in this regard.

Day 2: Feb 28, 2017

Session V: Malaria Prevention and Control Interventions

This session was moderated by Dr Ayele Zewdie. He invited the presenters of the session and the presentation was continued. The topics presented during this session were:

1. LLIN Durability Assessment Y1 Preliminary Finding: by Honelgn Nahusanay,
2. Malaria RDT lot ev,aluation in Ethiopia: by Sindew Mekasha
3. Recent findings of *P.ovale* and *P. malariae* in South Western Ethiopia: by Sindew Mekasha and
4. A small sacle variation in human exposure to malaria infection in Kolla Shara Villag, SW Ethiopia: an implication for targeted malaria control: by Endashaw Esayas.

After all completed their presentations, the presenters were invited to take seats in front of the participants and questions were raised for them.

The questions raised for the presenters and their responses were mentioned below:

✓ **Questions are raised on Honelgn's presentation the responses are summarized as follows.**
- Q. Why did you conduct repeated cross sectional study?
  - Response:
    > We used repeated cross sectional study for the chemical analysis. It is distractive procedure. During first year we didn't conduct chemical analysis because the nets were brand new. A year after that, the selected rephrased nets (210 nets) are distracted and we followed them. That is why we did repeated cross sectional study.
- Q. You are collecting your data by one year gap. How do you control for bias? What did you do to minimize recall bias?
  - Response:
    > To minimize recall bias, we have unique ID assigned and attached to each of the nets under follow up. So, we are not only relying on the response of the respondents. But, when they report the reason why the nets were lost, there might be recall bias. We will try to control that during control analysis.
  - ✓ Q. Reasons for each region's loss of LLIN must be kept rather than reporting. What is the reason for higher attrition in Amhara region?
  - Response:
    > We didn't go detail of it. I will take this an assignment to consider it for future.
  - ✓ Q. What did you mean when you say Attrition due to loss?
  - Response:
    > When we say attrition due to lost, it refers to a loss due to many reasons: the net might not be used (damaged totally), it could be totally lost (burned/stolen) or it can be used for other purposes. In our assessment we identified the reasons why the nets are lost. 'Lost' here means, those nets

which were not available for the intended purpose. Actually, the attritions are classified as attrition due to leakage and attrition due to unavailability.

- ✓ Q. When is lost to follow up considered?
  - ▪ Response:
    Lost to follow up is considered when the HHs is closed within a limited period of time during the visit or the HHs have totally changed their location due to other reasons. We have GPS coordinates of all the HHs and we track them back during follow up visits.
- ✓ Q. You said that some of the study participants used the LLIN for other purposes. For what kind of purposes did they use the LLIN? We want to know for what purpose they used that because cancer case in Ethiopia is increasing from time to time and this kind of exposures might have contribution for the upsurge.
  - ▪ Response:
    We have included questions which can help us to measure for what purposes the nets were used. Accordingly, we found that some of the nets are used for window screening and some to cover vegetables or grains.

- ✓ **Questions raised on Endashaw's presentation and his responses:**

- Q. You have clusters in your paper. How did you create those clusters? How did you select the village, the clusters and the HHs for your study?
  - ▪ Response:
    We selected a village and we used the already existing clusters of the selected village. From this, we calculated sample size to select HHs. Thus we selected 422 HHs for this parasitological study. From these, 591 individuals (from 90 HHs) were followed for six months (from July to December). Thus it is prospective follow up study, not cross-sectional study.
- Q. You reported that you took GPS for HHs. Did you take for all HHs in the village of your study or those HHs where involved in the study?
  - ▪ Response:
    GPS coordinate of each HH selected for parasitological (90 HHs) and entomological (25HHs) study was taken, for not the whole study areas.
- Q. Did you consider malaria transmission flight range? Did you tried to see distances in Km or in meters between the clusters?
  - ▪ Response:
    Yes we did. We've considered malaria flight range between clusters to avoid contamination. We considered a minimum of two kilometers between the clusters.
- Q. You reported that you took samples in July and July as we all know is not peak season for malaria transmission. Do you have any reason for including July to take samples for your study?
  - ▪ Response:
    We selected July intentionally because it is dry season for the areas around Arbaminch. The rainy season for this area is somewhat from September to December. July and August is dry season.
- Q. When you say small scale variation, how small is this 'small'?

- ▪ Response:

  When I say small scale variation, that is to mean malaria transmission vary at small scale at country level due to many factors. Malaria transmission even varies by area of 1km^2, also as suggested by this paper. So small scale is used to mean small area.

- **Comments**:
  - ▪ There is mess up in your study design. You took larger sample size for cross sectional study. (by Prof Ahmed Ali)
  - ▪ In your objective, you stated that you want to estimate the risk and incidence. But risk and incidence cannot be estimated from cross sectional study. At least, you need to conduct prospective study design to do that. (by Prof Ahmed Ali)
  - ▪ You tried to link the parasite data to GPS but you didn't do analysis for it. You need to conduct further analysis for this.
    - ▪ Response:

      I gladly accept the comments given for me by the participants.

✓ **Questions raised on Sindew's presentation and his responses:**
- Q. What we mean by RDT HRP2 gene deletion?
  - ▪ Response:

    Regarding to RDT HRP2 gene deletion, almost 90 % of the malaria RDTs produced by many manufacturers are targeted for HRP2. There is also increased number of HRP2 gene deletion reports. Recently, there is a report from Eritrea that about 80% of *P.falciparumalciparum* are not expressing HRP2 due to deletion of the gene. Such like deletions will lead to false positive readings. Those areas in Eritrea borders Ethiopia and we are designing a project to investigate the status of the RDTs used there. This is to help RDT selection to be evidence based.

- Q. You told us that the storage (temperature) and transportation are important to maintain sample quality. How can we achieve in our set up where there is very frequent power interruption? What mechanisms did you use in such like events?
  - ▪ Response:

    We have cold chain to monitor temperature and also we avoid keeping the window side to avoid direct contact with sunlight. We monitor the temperatures of the store by generators where there is power interruption.

- Q. Why do we bother for this *P. ovale* and *P. malariae?* What is the public health importance of these species? Is there therapeutic or diagnostic differences for these?
  - ▪ Response:

    It has implication from diagnostic point of view because we have only *P.falciparum* and *P.vivax* detecting kits. Also there can be question whether the current treatment/drugs are effective in treating *P.malariae* and *P.ovale* cases.

- Q. You didn't use the routine diagnostic mechanism we routinely use like laboratory or RDT to identify *P. ovale* and *P. malariae*. What was the possible result of the laboratory

investigation at facility level? Did they were treated for malaria or other AFI? If treated for malaria for which species they were treated for *P.falciparum* or *P.vivax*?

- ▪ Response:
  I haven't received detail diagnosis of the results from the facilities.
- Q. What did you mean when you say lot? You had elaborated the term 'lot testing'
  - ▪ Response:
    Manufacturer produce RDTs at a time; they produce from 60,000-80,000 tests at a time and they give one lot number or batch number for that product. That is to refer to quality difference between batches. And if there is a miss in one lot, all products of that generation will be useless.
- **Comment**:
  - ▪ Regarding to *P. ovale* and *P. malariae,* you didn't give us background for this which should be given.
    - ❖ Response: I will take the comments given for me.

Session VI: Malaria treatment/clinical pharmacology

This session was moderated by Dr. Matt Murphy. He invited the presenters of the session and the presentation was continued. The topics presented during this session were:

1. Invivo anti-malarial activity of ethnobotanically used Ethiopian medicinal plants: by Seyoum Desta,
2. Antimalarial activity of 80% methanolic extract of Brassica nigra (L.) Koch. (Brassicacae) seeds against Plasmosdium berhei infection in mice: by Abraham Belachew,
3. Investigation of mosquito larvicidal activities of some medicinal plants against Anopheles gambie: by Dr. Asfaw Debela and
4. Impact of wall surface types and spray application quality on efficacy of propoxur against malaria vectors in Sheillie mella, SW Ethiopia: randomized trial: by Zerihun Desalgn.

After all completed their presentations, the presenters were invited to take seats in front of the participants and questions were raised for them.

The questions raised for the presenters and their responses were mentioned below:

✓ **Questions raised on Mr. Seyoum's presentation and his responses:**

- Q. What seasonal condition did you consider when you collect the medicinal plants for this study?
  - Response:
    The extracts of the plants were collected in Addis Ababa and as you know, there is rain throughout the year in Addis. So we don't have worry for the activeness of the extracts.
- Q. How was the plant collection and interpretation procedures?
  - Response:
    The plants were collected in collaboration with botanist expert.
- Q. Did you get ethical clearance for your experiment?
  - Response:
    Yes we do. We also tried to apply the international standards of care with the animals.
- Q. What can you say about quality of your research including quality of microscopic examination in determining parasitaemia?
  - Response:
    Unfortunately, I am (the researcher) laboratory technologist and I also followed every procedures in detail in determining infected and non-infected ones. Therefore, I can say that the quality of the technical procedure is not compromised.

✓ **Questions raised on Dr. Asfaw Debela's presentation and his responses:**

- Q. Did you get ethical clearance for your study?
  - Response:

Yes we did. We got ethical clearance from Scientific and Research board of EPHI and we strictly followed the ethical requirements set for animals with maximal care.
- Q. Why you used traditional plants for your research rather than the known medicinal plants? What is the practical issue of using this plants?
  - Response:
    In fact the very basic information is originated from the community and we validated it with the scientific names. We are interested in this because the resource and the information are indigenous.
- Q. You recommended piloting at community level. Have you exhausted every steps? Are you ready to do that, especially in non-public organizations?
  - Response:
    Yes, we've exhausted the steps very well.

✓ **Questions raised on Mr. Zerihun Desalgn's presentation and his responses:**
- Q. Did you strictly followed the guideline to conduct the spray?
  - Response:
    Yes, but there can be spray-man commitment problem in implementing the spray. The other major problem is also that assigned supervisors simply counts the number of the structures sprayed and report on that but didn't strictly followed the producers.

✓ **Questions raised on Mr. Abraham's presentation and his responses:**
- Q. Which part of the plant is extracted?
  - Response:
    We extracted the seed, which our community commonly used for traditional treatment and prevention of malaria.
- Q. Can you say other factors are well controlled?
  - Response:
    Yes. The seed is collected and well dried under shade to prevent hydrolysis and the effect of sun light on the active pharmaceutical ingredients of the seed. Also during drying, the temperature is not allowed to exceed 40°C. I can say this has maintained the active ingredients accordingly.
- Q. Did you get ethical clearance for your experiment?
  - Response:
    Yes we do. We got clearance from School of Pharmacy, University of Gondar. Standards of care for the animals is done according to the guideline.

Session VII: Poster presentation and business meeting

This session which was moderated by Dr. Adugna, involved two major events, poster presentation and business meeting. Short summary of the three posters were presented and minute of the business meeting is presented below.

The economic burden of malaria and predictors of cost variability to rural households in South Central Ethiopia: The aim of this study is to estimate direct, indirect and the total cost of malaria to the rural households in Ethiopia. The study identified a total of 190 cases of malaria from Primary Health CareUnits from January–December 2015 in Adami-Tullu district in South-central Ethiopia, collected the data by face-to-face interview with the head of the household on the 10th day after treatment was initiated. It measured direct and indirect (income loss due to ill days) costs and used Kruskall-Wallis and Man-Whitney tests to compare the costs across different categories. It also employed Quintile (median) regressions to predict factors associated with variability of median cost of malaria. According to the study, the economic burden of malaria to the households in rural Ethiopia is substantial. Reducing malaria burden contributes to the economic welfare and poverty reduction. The national malaria program needs to recognize the burden, and identify mechanisms for ensuring that the poor have access to malaria treatment

Declining Pattern of Malaria Cases in Jimma Town and its Suburbs: a six-year retrospective: The objective of this study was to assess the trend of malaria cases in Jimma Town and correlate the cases with meteorological variables. After reviewing Six-year (January 2010 to December 2015) records of patients seeking treatment for fever at public health facilities in Jimma Town, the study concluded that a significant decline in malaria cases was recorded since 2010 in all the health facilities. Plasmodium vivax was the predominant Plasmodium species in the area. Control interventions should be intensified to sustain malaria control and to initiate elimination efforts in the area. A strategy should be in place to prevent relapse of vivax malaria in the area.

Reducing indoor exposure to bite of vectors by screening houses in malaria hotspot villages in Arba Minch town, south-western Ethiopia: a randomized trial: House is the major site for malaria infection where most human-vector contact takes places. Hence, houses screening might reduce the risk of malaria infection by limiting house entry of vectors. This study was assessed the impact of screening doors and windows on indoor density, sporozoite and entomological inoculation rate (EIR) of malaria vectors, and on malaria transmission in Gebeya Dar and Georges sub-Kebeles (Kebele-smallest administrative unit in Ethiopia) of Arba Minch town, southwest Ethiopia. According to this study house screening intervention has played a substantial role by reducing the exposure to malaria vectors, and hence can be recommended as an important intervention that could be included in malaria vector control package.

Business Meeting minutes

This was the last session of the symposium, which mainly focused on discussion regarding the activities done so far and to be done by the network. It was lead by Chair Person from EPHI (Dr Adugna), Secretariat from ACIPH (Dr Ayele) and the newly recruited Coordinator of the MRN (Dr Wondeatir). The chair person started his talk by acknowledging the activities carried out by network members and the secretariat institute ACIPH. The meeting addressed three agendas; annual report and discussion, membership issues and selecting next symposium host institute. Dr Ayele took the floor to present the objectives drafted by members of MRN during the past years and their implementation status. Accordingly, he reported as;

- Only one objective was fully achieved, that was "Creating platform to conduct MRN".

- The other two Objectives "to advocate the implementation of malaria research findings by program persons" and "to establish research data base for ease of access" were the objectives partially achieved.
- However the rest for objectives; "to facilitate and coordinate among stakeholders working on malaria research, "to promote quality research", "to identify key gaps/needs", "to technically support NMCP" and "to build capacity of researchers in institutions" were not initiated and also time frame was not set for these activities. Dr Wondeatir has added some ideas regarding the activities conducted so far and emphasized in the poor achievement of the network and welcomed the view of the participants. Following the finalization of the presentation from the stage, the MRN members were given the opportunity to forward their views.

Agenda # 1 brief report and discussion

Mr Asnake (PATH/MASPA) has started giving his idea as "there are many public universities working on malaria in the country but very few are taking part in this network. Hence, they should be encouraged and invited to be involved in the MRN. In addition to this the existing network among network members should be stronger. Dr Wakgari (AAU/SPH) gave a comment on the way the report was presented and suggested that there must be a reporting format or presentation template to present the achievements and the gaps/challenges encountered. He has also given a comment regarding the mentioned objectives and proposed them to be actionable. The issue of timing and modality of abstract submission was also proposed to be reviewed by the members. He has finalized his talk giving the comment on the presentation "Not Initiated" as it may indicate under achievement no achievement. Hiwot (PMI/USAID) has forwarded her ideas regarding what she think to be the main activities to be focused on; the data base, the website and representation in the ministry.

During the discussion, Mr Honelgn (ACIPH/SMMES) gave an idea regarding points of discussion. Concerning submission of abstracts, invitation letter was sent to different institutions and 35 abstracts were received with in short period of time. Thus, the issue of broadening the scope of invitation would be a valid comment. The other concern raised by Mr Honelgn was about the issue of legalizing the association, which was later addressed by Dr Adugna and Dr Ayele during answering about TOR. Dr Zelalem (malaria consortium) said the TOR should be in place to guide the member institutions as well as individuals. In this regards, Dr Ayele (The Secretariat) has said that the TOR is already prepared and commented during the 7th symposium, the only thing that we have not done was letting know the new members participating in this symposium. The Chair person (Dr Adugna) has also invited the young researchers to forward their view regarding the way to strengthen the network. Dr Asfaw (EPHI) has proposed some activities to be included in the major activities to be done by the committee that includes searching for grants so that quality papers will be emanated from member institutions and individuals as well as others.

Agenda # 2 membership issues

Dr Ayele briefed to the participants regarding the types of membership encompassed in the TOR. The first was Institutional membership and the second was individual's membership. He has admitted that due to different reasons currently the network don't have list of member at hand but it will work to avert this shortcoming soon. There is a plan to develop a member registration

form and send it to everyone. Dr Wakgari has raised a couple of questions such as; who will be responsible to identify potentials individuals and institutions working on malaria program, Who will be responsible to provide high level invitation, where will be the office of MRN and finally how can members communicate with the network. Prof Ahmed (AAU/SPH) has also added a comment on preparing eligibility criteria for membership. The chair person have answered majority of the concerns raised by the participants and proposed the following action points. Since the issue of membership is very crucial, in the next 2 weeks we will have full data of members. Through FMoH we will communicate potential institutions in the coming 1 month.

Agenda # 3 Next Meeting Venue

Regarding the venue of next symposium, representatives of University of Gonder has raised their full interest to accommodate the 9th MRN Symposium at University of Gonder and the whole participants including the Chair Person and Secretariat has totally agreed. The actual date of the next symposium was decided to be from November 27-28, 2017.

Table: Action Plan of 8th MRN, 2017

Concern/Challenge	Action item	Responsible person	Time
MRN-E website not developed	EPHI website is under reconstruction. Up on completion the MRN will have a page under the website	MRN Coordinator	TBD
The objectives were not presented with their respective actionable activities	All objectives will have clear list of actionable activities with specific time frame and assignments will given to member institutions	Chair Person Secretariat MRN Coordinator	Starting from March 1, 2017
Annual report format was not prepared	Annual reporting formats will be developed and used by the next symposium	Chair Person Secretariat MRN Coordinator	Nov 28, 2017
Minimal involvement of higher institutions and other organizations working on malaria program	Communicating with FMoH higher officials regarding the invitation of higher institutions and other organizations working on malaria program and provide higher level invitation	Chair Person Secretariat MRN Coordinator	Next two weeks (March 1-15, 2017)
Representative of higher institutions were not formally know	Up on membership completion higher institutions will delegate one person who will represent the specific institution	Chair Person Secretariat MRN Coordinator	TBD
Unavailability of members list	Forms will be developed and disseminated to all potential institutions and individuals and the members list will be documented and visible by all	Chair Person Secretariat MRN Coordinator All members	Next one month (March 1-30, 2017)
9th MRN Venue	Who will host the symposium	University of Gonder	November 27-28, 2017

Annex

Annex I: List of participants

S.no	Name	Organization
1	Hiwot Teka	USID / PMI
2	Terefe Gene	DEBRE BIRHAN UNIVERSITY
3	Abrham Belachew	WALLGA UNIVERSITY
4	Henock Hailu	GONDAR UNIVERSITY
5	Ashetu Hunduma	ACIPH / SMMES
6	Eyob Seife	ACIPH / SMMES
7	Alemayehu Getachew	AB/AIRS
8	Wondatir Nigah	EPHI
9	Mohammed Ahmed	St.PAUL/
10	Adefris Yared	St.PAUL/ college
11	Mitiku Seid	SPHMMC
12	Kalkidan Meketu	EPHI
13	Adugna Abera	EPHI
14	Geremew Tasew	EPHI
15	Wossenseged Lemma	GONDAR UNIVERSITY
16	Adugna Woyessa	EPHI
17	Getachew Eticha	EPHI
18	Sindew Mekashe	EPHI
19	Ahmed Ali	SPH
20	Wessenseged Tsegaye	SPHMMC
21	Dr wakgari Deressa	AAU/SPH
22	Dr Fekadu Massebo	AMU
23	Dr Hassen Mamo	AAU/CNS
24	Dereje Merrie	St.PAUL
25	Jemal Beksie	St.PAUL/MMC
26	Desta Birhane	SPMMC
27	Dr Kassahun Alemu	UOG
28	Samuel Girma	USID / PMI
29	Endalew Zemene	JIMMA UNIVERSITY
30	Abebe Asale	JIMMA UNIVERSITY
31	Agonafir Tekalegn	MC
32	Gashu Fentie	FMOH
33	Desalegn Nega	EPHI
34	Zewditu Bekele	EPHI
35	Kebenesh Engida	EPHI
36	Milion Kebede	EPHI
37	Tesfaye T/Mariam	EPHI
38	Alemayehu Desalegne Hailu	AAU/UIB
39	Robit Getachew	AAU/UIB
40	Mekonnen Yohannes	MEKELE UNIVERSITY
41	Asfawossen Solomon	SPHMMC
42	Yididia Sileshi	SPHMMC
43	Tilahun Desta	SPHMMC
44	Fitsum Tesfaye	EPHI
45	Zelalem Kebede	MALARIA CONNTIM
46	Hailemariam Defabachew	EPHI
47	Seble Girma	EPHI
48	Helina Legesse	EPHI
49	Birhanu Getachew	EPHI
50	Endashaw Esayas	ARBAMINCH UNIVERSITY
51	Taye Yohannes	Arbaminch Gidole woreda H Office
52	Solomon Kinde	Arbaminch Gidole woreda H Office
53	Misrak Abraham	ARBAMINCH UNIVERSITY
54	Asfaw Debella	EPHI
55	AshengeAssele	EPHI
56	Goitom Mehari	MEKELE TIGRAY RBH
57	Mulubrhan Assefa	MEKELE UNIVERSITY
58	Getahun Hailu	SPHMMC
59	Helen Tesfayohannes	SPHMMC
60	Asnakew Kebede	PATH
61	Gedeon Yeshanw	ABT AIRS
62	Daremyelesh Tshome	Y.12.HO
63	Fitsum Bekele	WOLAITA SODO UNIVERSIY
64	Azmeraw Mulualem	PFSA
65	Alemnesh H/Mariam	EPHI
66	Yonas Kebede	ACIPH
67	Wondie Alemu	EFMHACA
68	Meshesha Balkew	AAU/ALPB
69	Shikur Mohammed	SPHMMC
70	Asfaw Berihanu	EPHI
71	Nigusie Baye	SPMMC
72	Dawit Hawaria	YHMC
73	Zerihun Alemu	EPHI/SPHMMC
74	Mesfin Tigstu	SPHMMC
75	Ayenalem Tariku	EPHI
76	Habtamu Beyne	EPHI

77	Zinash Ayalew	
78	Adisalem Getachew	
79	Aklilu Negash	SPHMMC
80	Metekiya Menza	NMA
81	Ulfet Abdurehaman	SPHMMC
82	Tarriku Tadesse	SPHMMC
83	Misgana Bancha	SPHMMC /EPHI/
84	Zerihun Desalegn	ARBAMINCH UNIVERSITY
85	Tsion Demissie	USAID/GML
86	Addisu Mekonnen	EPHI
87	Alem Fanta	EPHI
88	Ehit molla Mamo	EPHI
89	Aynalem Agonafer	EPHI
90	Alemnesh Endale	EPHI
91	Melkam Dasalgn	EPHI
92	Henok Kebede	WHO
93	Getye Getneh	EPHI
94	Mohamed Abdilahi Adem	ESRHB
95	Tigist Adera	EPHI
96	Yeshiwas Gebeyew	EPHI
97	Tigist Teshome	EPHI
98	Tigist Worku	EPHI
99	Beletu Birehane Mesekel	EPHI
100	Mulugeta Guta	EPHI
101	Mulugojam Kaleab	EPHI
102	Kasahun Reta	EPHI

Annex 2: Schedule

8th Ethiopian Malaria Research Symposium
February 27 – 28, 2017, EPHI Public Health Training Center

| Time	Topics	Presenters
Day 1		
08:30- 09:00	Registration	ACIPH/EPHI
Session I: Moderator and Master of Ceremony – Dr. Wondatir Aragaw		
09:00- 09:10	Welcome	Dr. Adugna Woyessa (Chair of MRN-E)
09:10 -09:20	Key note address	FMOH
09:20- 09:30	Key note address	Dr. Matt Murphy, PMI
09:30- 09:40	Key note address	Dr. Ayele Zewde, ACIPH/SMMES
09:40-10:00	Opening speech	Dr. Ebba Abate, Director General
10:00-10:30	Tea Break	Organizers
Session II: Malaria and climate / Moderator: Dr. Wakgari Deressa		
10:30 – 10:50	Climate Sensitive Disease Early Warning Practices, Methodology and Available Tools at NMA	Henock Hailu
10:50 - 11:10	Malaria Elimination Climate Surveillance Suite (MECSS)	Dr. Adugna Weyessa
11:10-11:30	Repeated and seasonal survey highlights dominance of Plasmodium vivax in Ethiopian highland	Dr. Adugna Weyessa
11:30- 11:50	Preliminary result of The third Malaria Indicator Survey in Ethiopia (MIS 2015)	Ashenafi Assefa
11:50 - 12:30	Discussion	Participants
12:30- 01:30	Lunch	Organizers
Session III: Malaria and climate / Moderator: Professor Ahmed Ali		
01:30 -01:45	Assessment of climate variability on the episode and spread of malaria over Ethiopia	Metekiya Menza
01:45 -02:00	Variation in species composition and infection rate of Anopheles mosquitoes at different altitudinal transects, and the risk of malaria in the highland of Dirashe Woreda, south Ethiopia	Taye Yohannes
02:00 -02:15	Comparative entomological study on ecology and behaviour of anopheles mosquitoes in highland and lowland localities of Dirashe district, southern ethiopia	Terefe Gone
02:15 – 02:30	Distribution of monthly pneumonia case correlated with climatic zone in tigray region: ecological study	Mulubirhan Assefa
02:30 -03:00	Discussion	Participants

Time	Topics	Presenters
03:00-03:20	Tea break	Organizers
Session IV: Malaria Entomology / Moderator: Dr. Mekonnen Yohannes		
03:20- 03:35	Entomological investigations on *Anopheles arabiences* and Plasmodium species infection prevalence in seasonal migrant and non-permanent laborers in extra-domestic agricultural fields of Metema-Armachiho lowlands, Northwest Ethiopia	Wossenseged Lemma
03:35 - 03:50	Efficient attractants and simple odor-baited sticky trap for surveillance of *Anopheles arabiensis* Patton mosquito in Ethiopia	Dawit Hawaria
03:50 – 4:05	Entomological indicators of malaria transmission, and insecticide susceptibility status of *Anopheles arabiensis* in Sille village, south-west Ethiopia	Misrak Abraham
04:05 – 04:20	Zooprophylaxis as malaria control strategy for Anopheles arabiensis (Diptera: Culicidae): a systematic review	Abebe Asale
04:20 - 05:00	Discussion	Participants
Day 2		
Session V: Malaria Prevention and Control Interventions / Moderator: Dr. Ayele Zewde		
09:00- 09:15	LLIN Durability assessment Y1 Preliminary finding	Honelgn Nahusenay
09:15 - 09:30	Malaria RDT product lot evaluation in Ethiopia	Sindew Mekasha
09:30- 09:45	Recent findings finding of P. ovale and P. malariae in south western Ethiopia	Sindew Mekasha
09:45 - 10:00	A small scale variation in human exposure to malaria infection in Kolla Shara Village, southwestern Ethiopia: an implication for targeted malaria control	Endashaw Esayas
10:00 - 10:30	Discussion	Participants
10:30 - 11:00	Tea Break	Organizers
Session VI: Malaria treatment/clinical pharmacology Moderator: Dr. Matt Murphy		
11:00-11:15	Invivo anti-malarial activity of ethnobotanically used Ethiopian medicinal plants	Seyoum Desta
11:15 -11:30	Antimalarial activity of 80% methanolic extract of Brassica nigra (L.) Koch. (Brassicaceae) seeds against Plasmodium berghei infection in mice	Abrham Belachew Muluye
11:30 -11:45	Investigation of the mosquito larvicidal activities of some medicinal plants against Anopheles gambiae	Asfaw Debella
11:45 -12:00	Impact of wall surface types and spray application quality on efficacy of propoxur against malaria vectors in shellie mella, southwest Ethiopia: a randomized trial	Zerihun Desalegn
12:00-12:30	Discussion	Participants
12:30-01:30	Lunch	Organizers
Session VII: Moderator : Dr. Adugna Weyessa		

Time	Topics	Presenters
01:30- 02:30	Poster presentations session	Presenters
02:30- 03:00	Tea break	Organizers
03:00 -04:30	Business meeting on Malaria Research Network	Participants
04:30-04:45	Closing remarks	FMOH

Abstracts for Poster presentation

1	The economic burden of malaria and predictors of cost variability to rural households in South Central Ethiopia	Alemayehu Desalegne
2	Declining Pattern of Malaria Cases in Jimma Town and its Suburbs: a six-year retrospective	Endalew Zemene
3	Reducing indoor exposure to bite of vectors by screening houses in malaria hotspot villages in Arba Minch town, south-western Ethiopia: a randomized trial	Solomon Kinde
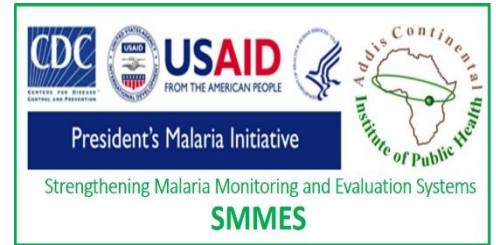
The 8ᵗʰ Malaria Research Network

Abstract Booklet

Feb 27—28, 2017

Addis Ababa

Assessment of climate variability on the episode and spread of malaria over Ethiopia.

Metekiya M. Gulacha
National Meteorological Agency of Ethiopia, Ethiopia

Abstract. Malaria is one of the most virulent infectious diseases which are highly sensitive to climate conditions. It is a persistent threat to health in developing nations including Ethiopia where it represents a major constraint to economic development measures and reduces the likelihood of living a healthy life, especially among women, children and the rural poor. The survival, reproduction and biting rate of mosquito, which transmit malaria, are strongly influenced by precipitation, temperature and relative humidity. Temperature has high impact on life cycle of infectious agents. Malaria almost kills one million people annually. In this study, the impact of climate variability on malaria spread over Ethiopia was assessed by using the three climate elements: temperature, Rainfall and relative humidity. The malaria transmission or spread (the rate of growth of malaria transmitting or Anopheles mosquito) was identified by malaria index (when mean monthly temperature is between 18-32oC, when mean monthly relative humidity is exceeds or equal to 60% and when monthly total rainfall exceeds or equal to 80mm). Malaria distribution throught the country is high during May to November time period. The malaria distribution and its occurrence are mainly in Kiremt and Belg seasons. Geographically, the distribution is high in lwland areas of the country. The lowland areas of Southern Nations Nationalities and People's Region (SNNPR), Western and Eastern Oromia, Westrn and Eastrn Amahara, Western and Eastern Tigray and most parts of Benishangulgumz are the most vulnrable areas of the country. Malaria outbreak is mainly in kiremt and Belg seasons where most of the nations carryout their agricultural activities, the health personals should have strategic plan.

Keywords: malaria index; Rainfall; Temperature; Relative Humidity; Ethiopia.

Presenting author details
Full name: Metekiya Menza Gulacha, Contact number: +251 926 322 995, Email: metekiya12@gmail.com, Twitter account: Metekiya Gulacha, Linked In account: metekiya Menza
Addis Ababa, Ethiopia

Variation in species composition and infection rate of *Anopheles* mosquitoes at different altitudinal transects, and the risk of malaria in the highland of Dirashe Woreda, south Ethiopia

Taye Yohannes Daygena[1, 2], Fekadu Massebo[1*] and Bernt Lindtjørn[3]

[1] Department of Biology, Arba Minch University, Arba Minch, Ethiopia

P. Box 21

Email: fekadu.massebo@amu.edu.et

[2]   Dirashe Woreda Health Office, Malaria and Other Vector Borne Diseases

Control Unit, Gidole, Ethiopia

Email: tayeyohannes1969@gmail.com

[3]   Centre for International Health, University of Bergen, Bergen, Norway

Email: bernt.lindtjorn@cih.uib.no

 Background: The transmission of malaria is heterogeneous, and varies due to altitude. The information on whether the transmission of malaria is indigenous or imported to highlands is scarce. Therefore, this study was aimed to assess the species composition and infection rate of *Anopheles* at different altitudinal transects, and the risk of malaria if any in the highland of Dirashe Woreda, south Ethiopia.

Methods: This study was conducted in Gato (low altitude; average elevation of 1273 m), Onota (mid altitude; average elevation of 1707) and Layignaw-Arguba (high altitude; average elevation of 2337 m) from August 2015 to April 2016. *Anopheles* mosquitoes were sampled using Centers for Disease Control and Prevention (CDC) light traps from thirty houses (ten houses from each village). The circum-sporozoite proteins (CSPs) rate and entomologic inoculation rate (EIR) of *Anopheles* mosquitoes were estimated. For epidemiological survey, malaria cases were collected from laboratory registration book of selected health facilities from (August 2015-April 2016). A cross-sectional survey was done to collect data on malaria vector control activities in each village (August/September 2015).

Results: 1268 *Anopheles* mosquitoes comprising *An. arabiensis, An. demeilloni, An. cinereus*, *An. pharoensis*, *An. funestus*-group, *An. pretoriensis*, *An. christyi*, *An. ardensis* and *An. tenebrosus* were documented in the study area. *An. arabiensis* was the dominant species in Gato, whereas *An. demeilloni* was the dominant species in Layignaw-Arguba. Five mosquitoes, three *An. arabiensis* from Gato and two *An. demeilloni* from Layignaw-Arguba, were positive for

Plasmodium falciparum CSPs. *P. falciparum* CSP rate was 0.4% (95% CI: 0.08-1.15) for *An. arabiensis* in Gato, and it was 0.64% (95% CI: 0.08-2.3) for *An. demeilloni* from LayignawArguba. The *P. falciparum* EIR of *An. arabiensis* was 8.6 (95% CI: 2.4-33.4) infectious bites per person/nine-months in Gato. *P. falciparum* parasite was dominant in Gato (88%) and Onota (57.5%), whereas in Layignaw-Arguba *P. vivax* (59.4%) occurred most frequently. Increased malaria cases were observed in children age 5-14 years in Gato (P < 0.05), whereas in Onota and Layignaw-Arguba there were no statistically significant difference in malaria cases among the age groups (P > 0.05). Households owning at least one Long Lasting Insecticidal Net were 92.7% in the study area and 77.6% slept under the net during the preceding night of the survey. About 64.4% of the households in Gato were protected by indoor residual spray. However, the spraying was done when the density of local malaria vectors was low.

Conclusion: The incrimination of *Plasmodium* CSP positive *Anopheles* species in high altitude Layignaw-Arguba justifies the existence of indigenous malaria transmission and the need for effective malaria control. Further investigation and confirmation using more sensitive molecular techniques is however needed to consider *An. demeilloni* as a proven vector of malaria in Ethiopia.

Key words: Altitudinal variation, *Anopheles arabiensis, Anopheles demeilloni,* Dirashe Woreda

COMPARATIVE ENTOMOLOGICAL STUDY ON ECOLOGY AND BEHAVIOUR OF ANOPHELES MOSQUITOES IN HIGHLAND AND LOWLAND LOCALITIES OF DERASHE DISTRICT, SOUTHERN ETHIOPIA

Authors: Terefe Gone, Meshesha Balkew and Teshome Gebre-Michael

Background: Change in climatic and socio-economic situations is paving the way for the spread of malaria in highland areas which were generally known to be malaria free. Despite this, information regarding highland malaria transmission is scarce. Thus, the present study investigated entomological parameters linked to malaria transmission in the highlands of Southern Ethiopia.

Purpose: to determine the ecology, behaviour, species composition, distribution and other entomological indicesof the vectors in the study area.

Methods: A longitudinal entomological study was conducted in three localities situated at different altitudes ranging between 1300 and 2650m above sea level in Derashe district, Southern Ethiopia. Larval and adult anopheline mosquitoes were collected between October 2011 and February 2012.

Results: *An. arabiensis* and *An. funestus* s.l existed at significantly higher densities in the lowland (Wozeka) in contrast to *An. christyi* and *An. demeilloni,* which were more abundant in the highland localities ($P < 0.01$). Conversely, *An. pharoensis* and *An. cinereus* were scarce and only found in the lowland and highlands, respectively. Habitats of larvae of *An. arabiensis* were characterized as clear, sun-lit, permanent, still water (streams) without vegetation and situated close to human habitations. On the other hand, habitats of *An. christyi* are shaded, still, turbid and contain natural water (rain pools) with vegetation and mats of algae. The relative abundance of *An. Arabiensis*, which is the primary malaria vector in Ethiopia, is significantly and positively correlated with water temperature, pH and average depth ($P < 0.05$). *An. arabiensis, An. funestuss.l* and *An. demeilloni* showed zoophilic and exophilic tendencies. None of the anophelines tested for *P. falciparum* and *P. Vivax* sporozoite infections were positive.

Conclusion: In conclusion, malaria parasites and vectors existed in the highlands of Derashe District. Therefore, appropriate disease and vector control strategies must be designed and implemented to prevent potential outbreaks.

Keywords: anophelines, Ecology, Behaviour

DISTRIBUTION OF MONTHLY PNEUMONIA CASE CORRELATED WITH

CLIMATIC ZONE IN TIGRAY REGION: ECOLOGICAL STUDY

Mulubirhan Assefa* (MPH), _Alemayehu Bayray (PhD), Amanuel Zenebe (PhD), et.al_

*correspondence author: mulubirhanassefa@yahoo.com or mulubirhan.assefa@mu.edu.et

Background: In Tigray region, pneumonia is the primary cause of morbidity and mortality in children's under age five. Childhood pneumonia can be triggered by climatic factors such as meteorological events, rainfall patterns, and temperature anomalies. Despite growing evidences on current and future health risks due to climate variability, there is relatively little evidence about the effects of climate on pneumonia; remains unknown in Tigray region of Ethiopia. The main aim of this research was to develop hypothesis on the correlation of monthly pneumonia distribution by climatic zone prior to the prediction of future pneumonia risks associated with climate variability.

Methods: an ecological study was conducted in 23 health centers found in Tigray region of Ethiopia. Climatically, the entire region classified as; hot semi-arid, cold semiarid, tropical savannah, oceanic, subtropical highland oceanic and warm-summer Mediterranean climatic zones. A monthly pneumonia case was extracted from Health facility OPD (outpatient department) registries from 2004-2008 E.C. The climatic zone classification for each health facilities was obtained from climate data organization. Statistical analysis was done using SPSS Version 20; multi-level analysis was performed after we have checked the assumption of Intra-class Correlation Coefficient (ICC) between-health facility i.e. 60%.

Result: the study found that the distribution of childhood pneumonia was varies by season that reaches peak during autumn (cold temperature) with a mean average of 55. Climatic zone-level analysis shown that pneumonia was high in Hot semi-arid climatic zone (mean average of 55) followed by subtropical highland oceanic, Tropical savanna, Cold semi-arid, Warm-summer Mediterranean and Oceanic climatic zones. According to the multi-level analysis of this study, Health Centers belongs to hot semi-arid climatic zone had an estimated residual of 22.58 which was ranked the highest; it estimates a mean childhood pneumonia of 67. The lowest mean average was estimated in health centers found in oceanic climatic zone which accounts 22 pneumonia cases per month.

Conclusion and recommendation: in conclusion the level and distribution of pneumonia cases was vary within-health facility, between health facility, and climate zone level. This might be due to the climatic variability of each climate zone. The researcher recommends that further study should be conducted to determine the association of climate variability (temperature, rainfall and relative humidity) and childhood pneumonia.

**Keywords**: childhood, pneumonia, climate, distribution, health facility, and seasonal

Entomological investigations on *Anopheles arabiences* and *Plasmodium* species infection prevalence in seasonal migrant and non-permanent   laborers in extra-domestic agricultural fields of Metema-Armachiho lowlands, Northwest Ethiopia.

Yibettal Aschale[1,2], Animen Ayehu[1] , Fantahun[1], Nega Dessie[1], Sisay Getie[1], Kassahune Alemu[3], Meserete Birhane[1], Habte Tesfa [1], Ligabaw Worku [1], Abebe Genetu[1] , Wossnseged Lemma*[1,4]

[1] Department of Medical Parasitology, Collage of Medicine and Health Sciences, University of Gondar.

[1,2] Department of Medical Laboratory Sciences, Debremarkos University.

[3]Department of Epidemiology and Biostat, Collage of Medicine and Health Sciences, University of Gondar.

[4]Tropical Infectious Diseases Research Center, Collage of Medicine and Health Sciences University of Gondar.

ABSTRACT

Background: In Ethiopia, scale-up vector control interventions (mass distribution of long-lasting insecticide-treated nets (LLINs) and indoor residual spraying (IRS)), artemisinin-based combined therapies (ACT) and improved diagnosis have resulted in nationwide reductions in mortality and incidence of malaria. In Metema-Armachiho lowlands, outdoor malaria transmission is the source of malaria or *Plasmodium* species infection for seasonal migrant and non-migrant laborers working in extra-domestic agricultural fields during rainy season. The aim of this research was to conduct entomological investigations to study behavior, habitats and breeding sites of *Anopheles arabiensis* in addition to determination of outdoor *Plamodium species* prevalence rates in seasonal migrant and non-migrant laborers. **Methods:** Center for Disease Control(CDC) – light traps were used to collect mosquitoes from Indoor, outdoor, agricultural fields, red Acacia trees and Combreretum trees to study habitat preference and biting and resting behaviors. All water bodies in the study areas were examined carefully for the presence of larvae and pupae by sampling the water using standard dipper (350ml) and visual observation in addition to estimating their density. To calculate *Plamodium* species infection rate in seasonal migrants and non-migrant laborers, blood samples

were obtained by random cluster sampling for Malaria rapid test ((RDT (HRP2/Pldh COMBO (Pf/PAN)) and Giemsa stained thick and thin blood smear for microscopy. **Results**: A total of 783 (307 *Anopheles arabiensis*; 476 culicins) were collected using 101 CDC-traps from July, August and November, 2016 from the study sites. Of the total 260 *An. arabiensis* dissected, 112 (43.1%) were parous compared to 33(12.7%) gravid, 47(18.1%) fed and 68 (26.2%) nulliparous. The abdominal status of *An. arabiensis* were statistical significantly different for different habitats (P <0.05). A total of 204 water bodies were examined, within 1 km range in the study sites, 49.01% (100/204) were found with the mosquito immature stages. The different types pools created by rain in pit borrow, car track prints and dry season stream were found as the most important breeding sites. Of the total of 250 study subjects (101 permanent and 149 seasonal migrant laborers) screened for *Plasmoduim* species infection, 15.1% (38) was found with *Plasmodium falciparum* in addition to 1.6% (4) with *Plasmodium vivax* and 4 % (10) with mixed *Plasmodium falciparum* and *Plasmodium vivax*. Seasonal migrant and non-migrant laborers showed no statistically significant differences for *Plasmodium* species infections (p=0.36). **Conclusion**: Failure to include outdoor malaria in extra-domestic agricultural fields in national malaria control program, *Plasmodium* species transmission in the areas could most probably create an obstacle for the ongoing malaria elimination efforts.

Key words: outdoor malaria; *Anopheles arabiensis*; migrant and non-migrant laborers; agricultural fields; *Plasmodium* species infection.

Efficient attractants and simple odor-baited sticky trap for surveillance of *Anopheles arabiensis* Patton mosquito in Ethiopia

Dawit Hawaria[1], Dante R Santiago[2], Delnesaw Yewhalaw[3]

1 Department of Social and Population Health, Yirgalem Medical Science College, Yirgalem, Ethiopia
2 Departments of Environmental Health Science and Technology, Jimma University, Jimma, Ethiopia
3 Department of biology, Jimma University, Jimma, Ethiopia

Abstract

Introduction: Many efforts have been made to ease the burden of malaria through vector control, among which is the development of odor-baited traps and evaluation of efficient attractants that could replace host odor. However, most traps and evaluated attractants are expensive, which poor communities cannot afford. This study was conducted with the aim to devise a simple and affordable odor-baited trap and to investigate effective but affordable attractants for trapping *Anopheles arabiensis*.

Methods: First, an odor-baited sticky trap was designed; next, an experimental study with the randomized design was conducted to evaluate the efficacy of selected attractants for trapping *Anopheles arabiensis* using newly developed trap from June to August 2014. Laboratory strain *Anopheles arabiensis* were obtained from the Adama Malaria Research and Training Center Insectary. Wild *Anopheline* mosquito larvae were collected from a temporary breeding site, reared in Asendabo Vector Biology Laboratory, and tested.

Results: A simple odor-baited sticky trap was designed. Selected attractants were tested for attracting efficiency using the designed trap. Among the evaluated attractants, cow urine, which was kept for four days, attracted significantly more wild population and laboratory strains of the *Anopheles arabiensis* than a worn sock alone and the combination of cow urine and a worn sock.

Conclusions: Although further comparison studies with other standard traps are needed, the designed trap in conjunction with efficient attractant is shown to be effective for mosquito surveillance. Of the tested attractants, cow urine was an efficient attractant both for the wild population and the laboratory strain of *Anopheles arabiensis*.

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Original Article

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Dawit Hawaria[1], Dante R Santiago[2], Delnesaw Yewhalaw[3]

[1] Department of Social and Population Health, Yirgalem Medical Science College, Yirgalem, Ethiopia
[2] Department of Environmental Health Science and Technology, Jimma University, Jimma, Ethiopia
[3] Department of biology, Jimma University, Jimma, Ethiopia

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Name: - Misrak Abraham Phone- 0921006201 Adress- Arbaminch University

Title: - Entomological indicators of malaria transmission, and insecticide susceptibility status of *Anopheles arabiensis* in Sille village, south-west Ethiopia

Abstract

In Ethiopia, vector control is the principal strategy to reduce the burden of malaria. The entomological indicators of malaria transmission such as density, sporozoite rate and entomological inoculation rate (EIR) are the major parameters to assess the impact of vector control interventions. The susceptibility of the malaria vectors also determines the effectiveness of insecticide based vector control tools. Hence, the main aim of the study was to assess the species composition, sporozoite rate and EIR, and insecticide susceptibility status of malaria vectors. A total of 33 houses (18 for Centre for Disease Prevention and Control (CDC) light traps and 15 for exit traps) were randomly selected to sample Anopheles mosquitoes from October 2015 to May 2016. The Plasmodium circum-sporozoite proteins (CSPs) of An. arabiensis and An. Pharoensis were determined using Enzyme-Linked Immuno-Sorbent Assay (ELISA) technique. Five Anopheles species were identified by CDC Light traps and exit traps. Anopheles arabiensis (80.2%) was the predominant species, followed by An. Pharoensis (18.5%). Anopheles pretoriensis, An. Tenebrosus and An. rhodesiensis were documented in small numbers. A total of 1056 Anopheles mosquitoes were tested for CSPs. Of which nine (eight An. arabiensis and one An. pharoensis) were positive for CSPs with the overall CSP rate of 0.85% (95% CI: 0.3-1.4). Four Anopheles were positive for P.vivax_210 and 5 were positive for P. falciparum. The P. falciparum CSP rate of An. arabiensis was 0.46% (95% CI: 0.13-1.2) and it was 0.54% (95% CI: 0.01-2.9) for An. pharoensis. The EIR of An. arabiensis was 10.1 infectious bites per/person (ib/p)/eight months. The highest EIR of An. arabiensis was found in February with 4.78 ib/p/month, following the highest density of An. arabiensis in January 2016. Anopheles arabiensis was resistant to dieldrin (4%), and deltamethrin (0.05%) with mortality rates of 57% and 71%, respectively. Permethrin (0.75%) and malathion (0.8%) showed possible resistance with mortality rates 90.4% and 92.5%, respectively. Anopheles arabiensis was fully susceptible to propoxur and bendiocarb. Based on the EIR of An. arabiensis, malaria is endemic in the Sille village, and the main malaria transmission was occurred from December 2016-February 2016. Hence, supplementary vector control interventions are required as the vector developed resistance to the insecticides used for impregnation of bed nets.

Key words: Anopheles arabiensis, entomological inoculation rate, insecticide resistance, Sille village, sporozoite rate

Zooprophylaxis as malaria control strategy for *Anopheles arabiensis* (Diptera: Culicidae): a systematic review

Abebe Asale[1*], Luc Duchateau[2], Brecht Devleesschauwer[2], Gerdien Huisman[2], Delenasaw Yewhalaw[3]

[1, 3]Jimma University, Ethiopia,

[2]Ghent University, Belgium

* Corresponding author

ABSTRACT

Zooprophylaxis is the use of wild or domestic animals, which are not the reservoir host of a given disease, to divert the blood-seeking mosquito vectors from human hosts. We here systematically reviewed zooprophylaxis to assess its efficacy as a malaria control strategy and to evaluate the possible methods of applying it. Electronic databases, PubMed Central, Web of Science and African Journals On line were searched using key terms: "zooprophylaxis" or "cattle and malaria" and reports published between January 1995 and March 2016 were consulted . Thirty-four reports on zooprophylaxis were retained for the systematic review. *Anopheles arabiensis* is an opportunistic feeder. It has a strong preference to cattle odor as compared to human odor but feeds on both hosts. Its feeding behavior depends on the available hosts, varying from endophilic and endophagic to exophilic and exophagic. Most studies assessed either passive or insecticide zooprophylaxis. Insecticide treatment of cattle proved useful in reducing the human biting rates and malaria incidence. Passive zooprophylaxis can be applied only in malaria vector control if cattle and human dwellings are separated in order to avoid the problem of zoopotentiation. The zooprophylaxis outcome varied across areas. It is, therefore, advised to use a site-specific evaluation of its effectiveness in vector control as the behavior of *Anopheles arabiensis* varies across localities and circumstances.

Key words: malaria, cattle, mosquito, vector control, Ethiopia

A small scale variation in human exposure to malaria infection in Kolla Shara Village,

southwestern Ethiopia: an implication for targeted malaria control

Endashaw Esayas[1*], Adugna Woyessa[2], Fekadu Massebo[1]

[1]Arba Minch University, College of Natural Sciences, Department of Biology

massebofekadu@gmail.com

[2]Ethiopian Public Health Institute, Addis Ababa, Ethiopia
adugnawayessa@gmail.com

* Correspondence: esu.endo@gmail.com

Abstract

Background: Due to the decline of malaria in many countries, there is an interest to eliminate malaria. Hence, it is important to understand the transmission pattern of malaria to deal with the malaria foci which could be the source of infection for the other community members. This study was aimed to investigate the transmission patterns of malaria to identify the clusters with higher risk of malaria infection towards the targeted malaria control interventions in Kolla Shara village, southwestern Ethiopia.

Methods: Both parasitological and entomological studies were carried out from July to December, 2016 in the five clusters of the village. A total of 591 (in 90 households) study participants were followed biweekly by house to house visit (active malaria case surveillance) for febrile cases. Blood films were collected from febrile cases for parasite detection using rapid diagnostic test and later confirmed by microscope. *Anopheles* mosquito collection was done biweekly in 25 randomly selected houses (five houses in each cluster). The *Plasmodium* circumsporozoite proteins (CSPs) rate of *An. arabiensis* and *An. pharoensis* were tested by using Enzyme Linked Immuno-Sorbent Assay (ELISA) technique.

Results: A total of 131 febrile cases were screened for malaria during the six months of followup period. Of these, 46 (35.1%) were microscopically confirmed malaria episodes. *Plasmodium falciparum* accounted for 58.7% (27/46) and 41.3% (19/46) was *P. vivax* malaria. The incidence of *P. falciparum* malaria varied significantly among the five study clusters. There were 27 microscopically confirmed *P. falciparum* cases, yielding an overall incidence of 0.10 episodes per

person-year. Of the 27 *P. falciparum* malaria episodes, 16 (59.3%) were in Abullo, 10 (37.0%) in Erze and only 1 (3.7%) episode was from Enmba cluster. Moreover, only 30% (27/90) households (in Abullo and Erze clusters) experienced 80.4% (37/46) of the total malaria episodes. *P. falciparum* was the predominant malaria parasite in Abullo (72.7%; 16/22) and in Erze clusters (66.7%; 10/15), whereas more *P. vivax* (83.3%; 5/6) was observed in Enmba cluster. Although malaria episodes occurred in all age groups, the incidence was higher in children age 5-14 years with IRR: 4.1 (95% CI: 0.7-9.1); p = 0.003. Seven species of *Anopheles* mosquitoes were documented, of which *Anopheles arabiensis* was the dominant species (70.5%), followed by *An. pharoensis* (10%). The highest number of *Anopheles* was collected from Abullo (47%; 511/1086) and Erze (32%; 348/1086) clusters. Of 733 *Anopheles* mosquitoes tested for CSPs, eight *An. arabiensis* were positive for *P. falciparum* CSP with the overall sporozoite rate of 1.1% (8/733). The overall estimated EIR of *An. arabiensis* was 5.7 infectious bites/person/6 months. Abullo cluster had SR of 1.7% (5/299) and EIR of 17.0 ib/p/6 months, and in Erze cluster, the SR was 1.4% (3/220) and its EIR was 10.6 ib/p/6 months.

Conclusion: Malaria transmission is heterogeneous and varied between the five clusters in a small village. Higher malaria incidence, sporozoite rate and EIR were observed in Abullo and Erze clusters. Hence, the malaria control programme could target those populations living in high malaria risk clusters. Moreover, intensifying the existing control interventions in these two malaria foci may make the greatest use of resources for effective malaria control.

	Title: *INVIVO ANTI-MALARIAL* ACTIVITY OF ETHNOBOTANICALLY USED ETHIOPIAN MEDICINAL PLANTS.			
	Name	**Qualification**	**Institution**	**Country**
1	Seyoum Desta	MSC, BSC.	EPHI	Ethiopia
	Contact Address: Seyoum Desta P.O.BOX 1242 EPHI Phone no 0914603059 email: seyoumdesta8@gmail.com			

Abstract

Background: Malaria is a major public health problem in the world in general and developing countries in particular, causing for about 80% of all malaria cases and about 90% of the deaths. *Plasmodium falciparum* has been reported to be resistant to the available drugs. Moreover, vectors have been reported to be resistant to the available vector control methods. So there is an urgent need for the development of new drug to alleviate the burden of the disease.

Objective: This study was aimed to investigate the *in vivo* anti-plasmodial activity of extracts of the water and methanol leaves of *C. aurea*, methanol extracts of *L. sativum* and *Z. scabra* traditionally used medicinal plants for malaria treatment.

Methods: A rodent malaria parasite, *Plasmodium berghei,* which was maintained at Aklilu Lemma Institute of Pathobiology laboratory, was inoculated into Swiss albino mice. The mice were infected with 1×10^7 parasites intraperitoneally. The extracts were administered in to the mice via gabage daily for four days starting from the day of parasite inoculation. The control groups received the same amount of solvent (vehicle) used to suspend each dose of the herbal drug. Chloroquine was used as a standard drug, and was administered through the same route.

Results: Except the methanolic extract of *Zehneria scara* all crude extracts did not produce symptoms of toxicity at 2000 mg/kg body weight of mice. Each extract showed variable level of parasitaemia suppression in dose related manner. Methanol extract of *Zehneria scabra* leaf produced highest suppression of parasitaemia (48.3%) at the dose of 600mg/kg. The methanol extract of *Lepidium sativum* showed 28.3% of suppression of parasitaemia at the dose of 600mg/kg.

Furthermore, methanol extract of *Calpurnia aurea* induced 15.2% suppression, whereas its water extract induce 35.03% at 600 mg/kg body weight.

Conclusion: Crude extracts of *Z. scabra*, *C. aurea* and *Lepidium sativum* had dose dependent suppression activity against *P. berghei*. Hence, further investigation using different experimental models and fractionated methods is needed.

Antimalarial activity of 80% methanolic extract of *Brassica nigra* (L.) Koch. (*Brassicaceae*) seeds against *Plasmodium berghei* infection in mice

Abrham Belachew Muluye[1*], Eshetie Melese Birru[2], Getnet Mequanint Adinew[2]

Background: Resistances to currently available drugs and insecticides, significant drug toxicities and costs and lack of vaccines currently complicated the treatment of malaria. A continued search for safe, effective and affordable plant-based antimalarial agents thus becomes crucial and vital in the face of these difficulties.

Objective: To evaluate the antimalarial activity of 80% methanolic extract of the seeds of *Brassica nigra* against *Plasmodium berghei* infection in mice.

Method: Chloroquine sensitive *P. berghei* (ANKA strain) was used to test the antimalarial activity of the extract. In suppressive and prophylactic models, Swiss albino male mice were randomly grouped into five groups of five mice each. Group I mice were treated with the vehicle, group II, III and IV were treated with 100, 200, and 400 mg/kg of the extract, respectively and the last group (V) mice were treated with chloroquine (10 mg/kg). The level of parasitemia, survival time and variation in weight of mice were used to determine the antimalarial activity of the extract.

Results: Chemosuppressive activities produced by the extract of the seeds of *B. nigra* were 21.88, 50.00 (P < 0.01) and 53.13 % (P < 0.01), while the chemoprophylactic activities were 17.42, 21.21 and 53.79 % (P < 0.05) at 100, 200 and 400 mg/kg of the extract, respectively as compared to the negative control. Mice treated with 200 and 400 mg/kg extract were significantly (P < 0.05) lived longer and gained weight as compared to negative control in four-day suppressive test.

Conclusion: From this study, it can be concluded that the seed extract of *B. nigra* showed good chemosuppressive and moderate chemoprophylactic activities and the plant may contain biologically active principles which are relevant in the treatment and prophylaxis of malaria, thus supporting further studies of the plant for its active components.

Keywords: Antimalarial activity, *Brassica nigra*, Malaria, Mice, *Plasmodium berghei*

Author details: [1]Department of Pharmacy, College of Medical and Health Sciences, Wollega University, Nekemte, Ethiopia; [2]Department of Pharmacology, School of Pharmacy, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia.

Contact address: Email: abrhambel@gmail.com; Cell Phone: +251-92-029-6782.

Investigation of the mosquito larvicidal activities of some medicinal plants against *Anopheles gambiae*

Asfaw Debella*, Yonas Woletaw, Kissi Mudi, Dawit Abebe, Girum Taye, Frehiwot Teka, Bruktawit Girma, Solomon G/Amanuel, Messay Getachew, Zenebech Adella, Beruk Teka, Samuel Woldekidane, Feyessa Challa, Worku Gemechu, Mekonnen Tadesse, Yehuwalashet Belete, Bruketawit Girma, Chrisitna Haile, Abel W/Tensi, Asgedech Sirak and Aynalem Lakew

Oral presentations

Ethiopian Public Health Institute, Directorate of Traditional and Modern Medicine, P.0. Box 1242

E-mail: asfawdebella@gmail.com *** presenter**

ABSTRACT

Background: Vector borne diseases are among the major causes of illness and death in many developing countries affecting substantial portion of the productive force. Malaria is one of the major diseases of public health importance in Ethiopia that is transmitted by *Anopheles* mosquito. Repellants (natural and synthetic) and synthetic larvicides were also used as a control measures. However environmental pollution, cumulative toxic hazards to humans and other non-target organisms, and resistance developed by the vectors to most of the insecticides currently in use has necessitated the search for alternative control measures. Medicinal plants with larvicidal properties have paramount importance for the local control of mosquito.
Objective: Evaluate the mosquito larvicidal effect of five medicinal plants against *An. Gambiae* and safety on mice and fish, and formulate the active extracts into appropriate dosage form and evaluate the efficacy and shelf life.
Methods: Laboratory reared and wild larvae at field set up by WHO protocol (WHO/VBC/75 583).for susceptibility of resistance mosquito larvae**.,**
Results. The result revealed that *Millettia ferruginea* (seeds) has an IC_{50} value of 6.25ppm for 70% ethanol extract and 3.25ppm for aqueous extract and *Albizia gummifera* (seeds)), IC_{50} value of 6.25ppm for 70% ethanol extract and 12.5ppm for aqueous extracts in the laboratory reared mosquito. The plants also found to have IC_{50} larvicidal value ranging 25 to 50 ppm on wild larvae at field set up. These plants showed higher activity compared to the other investigated plants. Acute toxicity studies of these plants on mice showed medium lethal dose (LD_{50}) values ranges from 150 mg per Kg to 450 mg per Kg when the aqueous extracts were administered intraperitonealy. Phytochemical investigation of the extracts used for the test revealed flavonoids for *M. ferrugina* and saponins for *A. gummifera* alkaloids as major constituents of the plants. The active extracts were formulated into effervescent tablet have good stability at room temperature and facilitates fast release of the constituents to maximize the larvicisal effects.
Conclusion: The crude extracts of these plants demonstrated stronger larvicidal effect and safety on non-target organism stresses the need for extended field evaluation, which could then be employed to play an important role in the control of the larvae of the vectors at their breeding site.

Key words: Malaria, Mosquito larvicidal, Medicinal plants, *An. Gambiae*

IMPACT OF WALL SURFACE TYPES AND SPRAY APPLICATION QUALITY ON EFFICACY OF PROPOXUR AGAINST MALARIA VECTORS IN SHELLIE MELLA, SOUTHWEST ETHIOPIA: A Randomized Trial

Zerihun Desalegn[1,2*], TekluWegayehu[2], and Fekadu Massebo[2]

[1] Arba Minch College of Health Sciences, Department of Clinical Nursing, Arba Minch, Ethiopia

[2] Arba Minch University, College of Natural sciences, Department of Biology, Arba Minch, Ethiopia

*Correspondence: zerdessa2013@gmail.com/ Mobile +251 912 0816 61/+251 936 4541 70

Abstract

Background: The residual lifespan of indoor residual spray (IRS) insecticide is a key importance for effectiveness of malaria vector control. Residual efficacy of IRS varied with different spray quality and wall surfaces types. This study assessed the impact of different spray quality and wall surface types on efficacy of propoxur against malaria vectors in Shellie Mella village in Arba Minch area, southwest Ethiopia.

Methodology: A randomized experimental trial was conducted in Shellie Mella, southwest Ethiopia from August - December/2016. There were two groups: one with routine spray by district health office as usual and other with standard spray by following WHO guideline. Thirty houses with three different wall types (ten smooth, ten rough and ten painted mud wall) were selected and randomly allocated into routine and standard spray. Three control houses (painted, smooth and rough) were selected from unsprayed nearby urban area for correction of mortality. Wild population of *Anopheles gambiae* complex was used for wall bioassay tests. Data were analyzed by SPSS version 20 by using two way mixed model Analysis of Variance. The mean variation between wall and spray type were compared by post-hoc analysis.

Result: The knockdown and mortality rate were varied significantly on different wall and spray types. On standard spray, knockdown rate was 95.3% on painted, 82% on smooth and 72.5% on rough surface. On routine spray, it was 82.7% on painted, 48.7% on smooth and 60% on rough surface at week 17. On standard spray, mortality rate of wild *Anopheles gambiae* complex was 99.3% on painted surface; it was 90% on smooth and 80% on rough surface. On routine spray, it was 89.3% on painted, 61.3% on smooth and 65% on rough surface at week 17 post-spray. The

painted wall type showed highest knockdown and mortality rate during 17 weeks post spraying irrespective of spray types. The lower mortality rate and residual effect was seen on routine smooth and rough wall types. The residual efficacy of propoxur (mortality rate > 80%) was more than 17 weeks on standard spray regardless of wall types and it was less than 17 weeks on routine spray except painted wall surface.

Conclusion: The types of wall surface sprayed and spray quality affects the residual efficacy of propoxur. The painted wall surface and standard spray showed better residual efficacy. Therefore, it is recommended to consider wall surface available in the community to estimate the residual lifespan of the insecticide, and to strictly follow spray guideline for correct and consistent spraying.

Key terms: Carbamate insecticide, mortality rate, routine spray, Shelle Mella, standard spray, wall type

Annex 3: Abstracts

Abstract 1: Ethiopian Malaria Indicator Survey (MIS-2015): A Work in Progress

Background: Malaria is among the major health problems in Ethiopia. Two large scale household malaria indicators surveys (MISs) were conducted in 2007 and 2011, to measure the coverage and utilization of key malaria interventions. MISs complements the HMIS and the routine malaria control monitoring and evaluation systems. These surveys indicated that the implementation of malaria prevention and control interventions improved significantly in recent years. A follow up survey, MIS 2015 is being conducted to measure attainment of goals set in the 2011-2015 national malaria strategic plans.

Methods: Malaria Indicator Survey (2015) is a nationally representative, population based cross-sectional survey. Two stage cluster probability sampling technique was used to select 555 enumeration areas (EAs) and 13,875 households from all malaria endemic and epidemic prone areas of Ethiopia. The survey used two questionnaires (household and women's questionnaires) as data collection tool. These questionnaires were uploaded in to smart phones using Open Data Kit (ODK) platform. 326 data collectors organized in to 36 teams who were selected from regional health bureaus were trained on objectives and rationale of MIS, questionnaires, biological sample collection, GPS recording and navigation and interview techniques. Data collected from 555 EAs were actively sent to the central server from the field. Data downloaded from the server in to XL spread sheet are under cleaning and analysis.

Results: Data were downloaded in six modules from the EPHI central server. The data were checked for completeness and consistency. 100,159 households were mapped in all 555 EAs, on average 180 households were mapped per EA. 13,875 HHs were selected for interview. Of these, 13,374 HHs were interviewed, with a non-response rate of 3.6%. 15,941 blood samples were collected to diagnose malaria using blood slide and dried blood spot (DBS) and 7,325 hemoglobin measurements were taken for children under five.

12,404 women were included in the survey with a response rate of 92.87%. Data cleaning and first round slide reading are completed. The unweighted malaria prevalence by RDT and microscopy is 2.4% and 1.1% in all surveyed areas, respectively. The data analysis will be conducted starting from February 29, 2016.

Conclusion & the way forward: The MIS 2015 planning and data collection were completed successfully with the concerted effort of all partners. Local capacity is built for the planning and management of MISs. The crude results show that malaria prevalence was reduced in 2015 compared to 2011. Further data summarization and analysis is expected to reveal programmatically important evidences. MIS-2015 results will be made available by end of March 2016 and results will be disseminated in June 2016.

Abstract 2: Malaria Related Perceptions, Seeking Care after Onset of Fever and Anti-Malarial Drug Use in Malaria Endemic Settings of South West Ethiopia

Zewdie Birhanu[1], Lakew Abebe[1], Morankar Sudhakar[1], Gunawardena Dissanayake[2], Yemane Ye-ebiyo Yihdego[3], Guda Alemayehu[2], Delenasaw Yewhalaw[1]

[1]Jimma University, [2]United States Agency for International Development, [3]Abt Associates, Africa Indoor Residual Spraying

Background: Prompt care seeking and appropriate use of anti-malarial drugs are critical components of malaria prevention and control. This study assessed malaria related perceptions, care seeking behavior and anti-malarial drug use in malaria endemic settings of Ethiopia.

Methods: Data were generated from a community based cross sectional study conducted among 798 households during January 2014 in three districts of Jimma zone, Ethiopia. Quantitative and qualitative data were collected and analyzed by SPSS 17.0 and STATA 12.0.

Results: 76.1% of the respondents associated malaria to mosquito bite and incorrect beliefs and perceptions were noted. Despite low level of comprehensive knowledge (mean =58.1%, SD=17.1%), attitude towards malaria prevention was high (Mean =92.2%, SD=7.0%). Among study participants with fever, 86 (74.1%) sought care where all of them consulted formal health care system. However, only 17 (19.8%) of them sought the care within 24 hours after onset of fever. The frequency of seeking care was higher (77.8%) and quicker (28.6%) for children although statistically significant difference did not exist (p > 0.05). However, higher median time of seeking first care was observed for people who are affiliated with Muslim religion and among people who did not attend school (p < 0.05). Inappropriate use of anti-malarial drugs such as saving and sharing was reported. Irregular availability of anti-malarial drugs and frontline health workers; misconceptions contributed to delayed care seeking and irrational use of anti-malarial drugs.

Conclusions: Although care seeking behavior for febrile illness was common in this community, the habit of prompt seeking care was very limited and influenced by individual perceptions and system related factors.

Recommendations: Malaria prevention and control programs need to take into account local misconceptions and wrong perceptions, and health system factors to achieve optimal health seeking behavior in such malaria endemic settings.

Key words: Malaria, Seeking Care, Malaria Related Perceptions

Abstract 3: Anopheline Mosquito Species Composition, Density, Longevity and Malaria Prevalence around Gilgel-Gibe Area, Southwest Ethiopia

Alemayehu Dagne[1], Abebe Asale[1], Behailu Taye[2], Abdissa Gurmessa[3], Delenasaw Yewhalaw[1]

[1]Jimma University [2]Gambells University [3]Jimma University

Background: Construction of dams and irrigated farm lands may contribute for breeding of anopheline mosquitoes. In this paper, we investigated the effects of a mega hydropower dam on *Anopheles* mosquito species composition, density, longevity and malaria prevalence.

Methods: Longitudinal entomological study was conducted from June to December 2013 in two *kebeles* in Tiro Afeta district in Jimma zone, Southwest Ethiopia. Adult anopheline mosquitoes were collected using Centers for Disease Control light traps and pyrethrum spray catches in the two *kebeles* (Koticha Gibe, located near Gilgel-Gibe hydroelectric dam and Decha Nadi, located away from the dam). Moreover, record of malaria cases in the health facilities was reviewed.

Results: Overall, 1521 adult anopheline mosquitoes belonging to two species were collected. *An. gambiae* s.l. was the predominant species (72.9%) followed by *An. coustani* (27.1%). The mean monthly *An. gambiae* s.l. density, collected by light trap catches and pyrethrum spray catches was 5.6 per trap/night and 3.51 per house, respectively. The density of *An. gambiae* s.l in Koticha Gibe was higher (8.5 per trap/night and 5.6 per house/day) than that of Decha Nadi (2.71 per trap/night and 1.95 per house/day), respectively. There was significant difference in mean monthly *An. gambiae* s.l. density between the two *kebeles* (P = 0.04). However, there was no significant difference between mean indoor and outdoor density of *An. coustani* in the two *kebeles* (P > 0.05). Post intervention (IRS operation and LLITNs distribution), degree of exophily increased from 1.61 to 1.28 and 1.35 to 1.23 in Koticha Gibe and Decha Nadi *kebeles*, respectively. Overall probability of daily survival

of *An. gambiae* s.l. decreased from 0.70 to 0.56 post intervention. Prevalence of malaria in the study setting was 10.71%, with no significance difference between the two *kebeles* (P = 0.052).

Conclusion: The findings of the study show that the dam creates favorable breeding site for mosquito population as compared to farther areas.

Key words: Mosquito density, malaria prevalence, Gilgel-Gibe dam, Ethiopia

Abstract 4: Assessment of Current Malaria Status in Light of the Ongoing Control Interventions, Socio-Demographic and Environmental Variables in Jiga Area, Northwest Ethiopia

Seble Ayalew[1], Hassen Mamo[1*], Abebe Animut[2], Berhanu Erko[2]

[1]Department of Microbial, Cellular and Molecular Biology, College of Natural Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia, [2]Aklilu Lemma Institute of Patho biology, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia

Following substantial decline in malaria burden in Ethiopia, the country is planning to eliminate malaria in certain low transmission settings by 2020. To evaluate the attainability of this goal in-depth examination of malaria parasite carriage at community level is necessary. This study was, therefore, aimed at assessing the current situation of malaria in relation to ongoing control interventions in Jiga area, JabiTehnan District in northwest Ethiopia.

Methods: A cross-sectional household (HH) survey was conducted in November-December 2013. Out of 2,574 HHs (11,815 people) in the entire Jabi Tehnan District, 392 (accommodating 1911 people) were randomly selected from three purposely selected villages. One randomly selected member from each selected HH was tested for malaria using rapid diagnostic test (mRDT).

Result: All participants tested for malaria (n = 392) were afebrile (axillary temperature <37.5°C). Eleven individuals (2.8%, 95% confidence interval (CI):1.2–4.4%) were found to be mRDT positive. Most HHs (95.9%, 95% CI: 93.5–97.5%) had at least 1 long-lasting insecticidal net (LLIN). Insecticide residual spraying (IRS) coverage the last six months was 85.5% (95% CI: 82.0–88.9%). Malaria prevalence remains unexpectedly high despite high HH coverage of control interventions.

Conclusion: Although LLIN and IRS coverage at HH level was encouragingly high in the study area, asymptomatic malaria infection is persistent among the study participants. Carefully-coordinated regular surveillance and response systems must be in place to thoroughly address the impact of ongoing control interventions and associated risk factors in the locality. The findings are believed to contribute towards improving malaria control efforts in Jiga and its surroundings

Abstract 5: Vector Behavior and Density Monitoring in Southwestern Ethiopia in Relation to Pre- and Post-Indoor Residual Spray Operation: Implications for Malaria Control

Kidane Lelisa[1], Behailu Taye[2], Daniel Emana[3], Abebe Asale[3], Delenasaw Yewhalaw[3]*

Affiliation: [1]Dilla University, [2]Gambella University, [3]Jimma University. *Corresponding Author

Background: This study was conducted to assess entomological parameters of anopheline mosquitoes in Kersa district, Jimma zone, southwestern Ethiopia from June, 2012 to December 2012. Purposes/Aims:-To assess anopheline mosquito species composition, behavior longevity and infectivity rates pre and post indoor residual spray operation.

Methods:- Mosquito collection was carried out from each selected households in each of the 9 selected study villages using Center for Diseases Control(CDC) light traps and pyrethrum spray catches (PSCs) for 7 months (June to December 2012). Vector; parity rates, gonotrophic cycle, Degree of exophily and Parasites sporogonic cycle were compared pre and post indoor residual spray. While Fed, gravid and unfed head thorax of Anopheles gambiae senso lato's sub-sample specimen collected by Light Trap Catches and Pyrethrum spray catches was used for circumsporozoite protein detection using Enzyme-linked immunosorbent assays (ELISA). Mosquito count data were log transformed before analysis and the data were analyzed using Statistical Package for Social sciences (SPSS) software package version 16.0.

Results:-Overall, 1,559 adult female Anopheline mosquitoes representing at least 3 species were collected from June to December 2012, from the nine study villages. Anopheles gambiae senso lato (71.8%) was the most abundant species, followed by Anopheles coustani senso lato (22%) and Anopheles pharoensis (6.2%). The mean monthly density of Anopheline mosquito species was highly significant (p<0.001). Significantly (p<0.05).The fed to gravid ratio of Anopheles gambiae senso lato pre and post Indoor Residual Spray operation was 1.5:1 and 6:1, respectively. The longevity of Anopheles gambiae senso lato Pre and post Indoor Residual Spray operation were 7.32 and 2.94 days respectively. Two Anopheles gambiae senso lato specimens were found positive for plasmodium vivax210 polymorphs and the overall infectivity rates was estimated to be 1.04 %.

Conclusion: We conclude that the malaria vector has developed mechanisms of deterring indoor residual spray though the operation has significant impact on their life expectance and preventing to reach infectivity rates.

Recommendation: We recommend the study community, the national malaria control authority and other stockholders to use the finding of this study that could contribute to the understanding of

anopheline mosquitoes: composition, dynamics, distribution, life expectancy, behavior and infectivity rates of principal vector in Kersa district; hence could used for evidence based malaria vector control program.

Key word(s); Vector Behavior, Party rate pre and post Indoor residual spray operation, infectivity

Abstract 6: Seasonal dynamics, biting activity and longevity of Anopheles mosquitoes in Southwestern Ethiopia

Behailu Taye[3], Kidane Lelisa[2], Daniel Emana[1], Abebe Asale[1], Delenasaw Yewhalaw[1*]

[1] Jimma University, [2]Dilla University [3]Gambella University

Introduction: Continuous monitoring of vector species composition, abundance, dynamics, feeding pattern, and host finding strategy is the base to determine when, what, and how control should be implemented. Thus, this study was aimed to assess entomological parameters of anopheline mosquitoes in nine villages in Seka district, southwestern Ethiopia.

Methods: Mosquito collection was carried out from selected households in each of the nine study villages using light trap catches from June to December 2012. Differences in mean mosquito density, parity rates before, and after indoor residual spraying (IRS) operation were compared.

Results: In total, 1,136 adult female anopheline mosquitoes were collected during the study period. All anopheline mosquitoes collected belong to three species. *Anopheles gambiae* senso lato Giles was the most predominant (69.7%) followed by *Anopheles coustani* senso lato Laveran (22.7%) and *Anopheles pharoensis* Theobald (7.6%). There was significant variation in mean mosquito density among An. gambiae senso lato, *An. coustani* senso lato, and An. pharoensis. Parity rate of An. gambiae s.l. before spray operation was significantly higher than after spray operation. The highest peak biting activity of An. gambiae s.l. was between 1800 and 2100 hours. The longevity of *An. gambiae* senso lato ranged from 3.4 to 12.5 d. The highest vector abundance and parity rate were recorded in July and August.

Conclusion: In conclusion, the behavioral plasticity and early biting activity of *An. gambiae* senso lato could affect current vector control tools (IRS and long lasting insecticidal nets). Recommendation**:** Hence, it is imperative to explore intervention tools for outdoor malaria vector control in addition to the existing IRS and long-lasting insecticidal nets.

Key words: mosquito longevity, parity rate, infectivity rate

Abstract 7: Impact of housing condition on indoor-biting and indoor-resting *Anopheles arabiensis* density in a highland area, central Ethiopia

Abebe Animut, Meshesha Balkew and Bernt Lindtjørn

Background: Exposure of individuals to malaria infection may depend on their housing conditions as houses serve as biting and resting places of vectors. This study describes the association of housing conditions with densities of indoor-biting and indoor-resting *Anopheles arabiensis* in Hobe, Dirama and Wurib villages of a highland area in central Ethiopia.

Methods: Data on housing conditions, including presence of house apertures, number of occupants and number and the type of domestic animal tethered inside, were collected. Indoor-biting mosquitoes were sampled using Centers for Disease Control (CDC) light traps and indoor-resting mosquitoes sampled with pyrethrum spray catches (PSCs) monthly for two years (July 2008 to June 2010). Female anophelines were identified to species and processed. Univariate and general linear estimating equation allowing for repeated measures were used to assess the contribution of housing conditions for indoor-biting and indoor-resting *An. arabiensis*.

Results: About 96% (4,597/4,788) of anophelines were caught inside residential houses. Nine anopheline species were identified, among which *An. arabiensis* was most prevalent (2,489; 52%). Vectors entering houses were higher in those situated at low ($\beta = 4.475$; 95% CI $= 3.475$-5.476; p <0.001; $\beta =$ strength of the association) and medium ($\beta = 2.850$; 95% CI $= 1.975$-3.724; p <0.001) altitudes compared to high altitude, and where houses have no windows ($\beta = -0.570$; 95% CI $= -1.047$-0.094; p $= 0.019$) compared with those that have. Numbers of indoor-resting vectors were higher in those situated at low ($\beta = 6.100$; 95% CI $= 4.571$-7.629; p <0.001) and medium ($\beta = 4.411$; 95% CI $= 2.284$-6.537; p <0.001) altitudes compared to high altitudes, and where houses had open eaves ($\beta = 1.201$; 95% CI $= 0.704$-1.698; p <0.001) compared with those that had closed eaves.

Conclusion: Housing conditions such as presence of open eaves, absence of window, location at low and mid altitudes, were strong predictors of indoor exposure to *An. arabiensis* bite in a highland area of south-central Ethiopia.

Abstract 8: Seasonal pattern and behavioral study of *Anopheles gambiae* s.l. in Oromia region - Ethiopia

Alemayehu Getachew Tesfaye [1], Gedeon Yohannes Anshebo [1], Josephat Shililu[1], Dereje Dengela [2], Lena Kolyada [2], Christen Fornadel [3], Kristen George [3], Gunawardena Dissanayake [4] and Sheleme Chibsa [4]

Background: The 2015 entomological monitoring activities included year-round collection of data on vector density and species composition to help understand the abundance, seasonal patterns, biting behavior, parity of anopheline mosquitoes and assess the impact of IRS on entomological indicators. During the reporting period (March –February 2016), monthly pyrethrum spray catches (PSC), human landing catches (HLC), CDC light traps and window exit traps were carried out in two intervention (sprayed) sites and one control (not sprayed) site.

Methods: The intervention sites were in Gobu Sayo and Seka Chekorsa Districts. One site from Ilugelan District, Ijaji Town, was selected as an unsprayed control site. HLC was used in two households in each sentinel site for two nights per month. PSC was used to sample indoor resting mosquitoes in 20 houses in each of the study sites every month. CDC light traps were installed in two houses adjacent to houses selected for HLC in each of the three sentinel sites, and window exit traps were installed in four selected houses in each site. A total of 7,459 female anopheline mosquitoes comprising six species were collected.

Result: The most abundant species were *An. gambiae* s.l. (32.9%), *An. coustani* (35.3%) and *An. pharoensis* (31.2%). Overall, the main vector of malaria in Ethiopia, *An. gambiae* s.l., started proliferation in the month of April and reached its peak at variable times between June and September, with densities dropping from October onwards. In the control site peak density was achieved in September. *An. gambiae* s.l. was most abundant during the peak rainy period (June – August) in all sites though peak density was achieved at variable times. *An. coustani* was the dominant anopheline species collected from August onwards. Indoor resting density and human biting rates as measured by PSC and human landing catches, respectively, dropped after IRS in both intervention sites but increased and peaked in September in the control site. The resting habits of *An. gambiae* s.l. were variable by site. *An. gambiae* s.l. tended to exhibit endophilic tendencies in both intervention sites while it was more exophilic in the control site when we compared fed versus half gravid and gravid in PSC collections. The number of *An. gambiae* s.l. resting indoors reduced

drastically after IRS in the intervention sites compared to the control site. *An. gambiae* s.l. tended to feed more outdoors than indoors showing exophagic tendency in the two intervention sites (59.4% Gobu Sayo; 64.0% Seka Chekorsa) but tended to show endophagic tendencies in the control site (53.1% Ijaji). However, the difference in feeding tendencies within sites was not significant. *An. gambiae* s.l. engaged in biting throughout the night but peak biting was variable between sites, with Gobu Sayo and Ijaji recording post-midnight biting activity (01.00 – 03.00 hours). In Seka Chokorsa a higher proportion of host-seeking *An. gambiae* s.l. was collected before midnight (19.00 – 23.00 hours).Monthly parous rates for *An. gambiae* s.l. were variable between sites throughout the period of study with generally higher rates recorded between April and August in the intervention sites (Gobu Sayo: 76.8 – 100; Seka Chekorsa: 33.3 – 67). Parous rate greatly reduced in both intervention sites after IRS but remained the same in the control site. In the Ijaji control site parous rates remained high during the whole period of study (93.3 – 100). The present study characterizes the bionomics of *An. gambiae* s.l. and provides relevant information to be considered in planning and implementation of vector interventions. The longitudinal vector density monitoring studies conducted indicated that the main malaria vector *An. gambiae* s.l. started proliferation in April, reaching a peak in September based on results from the control site.

Conclusion: Based on these results, conducting IRS in the month of May/June with long-lasting insecticides would most probably provide sufficient protection. In the use of insecticides with short residual life, implementation of IRS in early August would be recommended. Indoor resting densities as well as mean human biting rates considerably declined after IRS in both intervention sites, most likely due to the effect of insecticide sprayed. These results provide a basis for improved targeting of IRS for enhanced impact on malaria transmission.

Keywords: DEET, MyggA, Chinaberry oil, Neem, *Anopheles arabiensis*, Vector, Repellent, Niger seed/noog/

Conclusion: Housing conditions such as presence of open eaves, absence of window, location at low and mid altitudes, were strong predictors of indoor exposure to *An. arabiensis* bite in a highland area of south-central Ethiopia.

Abstract 9: Malaria Incidence and Assessment of Entomological Indices among Resettled Communities in Ethiopia: A Longitudinal Study

Teshome Degefa*, Ahmed Zeynudin*, Ameyu Godesso*, Yohannes Haile Michael*, Kasahun Eba*, Endalew Zemene*, Daniel Emana*, Belay Birlie*, Kora Tushune* and Delenasaw Yewhalaw*

*Jimma University

Background: Population resettlement has been considered among factors that may increase risk of malaria transmission. This study reports, the impact of resettlement on malaria incidence and entomological indices among communities resettled in suburbs of Jimma town, southwestern Ethiopia.

Methods: A cohort of 604 study participants (302 resettlers and 302 non-resettlers) was monthly followed-up from September to November 2013 using active case detection. Moreover, longitudinal entomological study was conducted from June to November 2013. Anopheline mosquitoes were collected using Centers for Disease Control light traps and pyrethrum spray catches. Sporozoite enzyme-linked immunosorbent assay was performed to determine *Plasmodium* infection rates.

Results: Overall, 112 malaria cases were recorded during the three-month follow-up, of which 74.1% of the cases were from resettlement villages. *Plasmodium falciparum* incidence from resettlement and non-resettlement villages was 52.5 and 14.5/1,000 person-months at risk, respectively. Resettlement villages were three times at higher risk of *Plasmodium* infection (OR = 2.8, 95% CI: 1.22-6.48). *Anopheles gambiae* s.l. was the predominant (86.6%) of all the collected anopheline mosquito species. *Plasmodium* sporozoite rate in the resettlement and non-resettlement villages was 2.1 and 0.72%, respectively. *Plasmodium falciparum* entomological inoculation rate for *An. gambiae* s.l. in the resettlement and non-resettlement villages was 13.1 and 0 infective bites/person/night, respectively. Both sporozoite and entomological inoculation rates were significantly higher in the resettlement villages (p < 0.05).

Conclusion: Resettled communities were at higher risk of malaria infection as compared to non-resettled communities. Special attention should be given to malaria control interventions during resettlement programmes.

Keywords: Malaria, Incidence, Anopheles, Entomological indices, Resettlement, Ethiopia

Abstract 10: Situational analysis on the people experience with insecticide treated net in Kolla Shelle, South West Ethiopia

Epherem Damene, Wondemeneh Mekuriaw, Fekadu Massebo

*Arba Minch University

Background: The widespread implementation of insecticide-treated nets is a major intervention strategy likely to significantly reduce morbidity and mortality from malaria across Africa when used correctly. This study evaluates the coverage, use and condition of insecticide-treated nets owned by house hold in study area.

Methods: This cross sectional study was conducted in Kolla Shele kebele, Gamo Gofa Zone, South West Ethiopia. The study participants were randomly selected from study area and were interviewed about ownership and utilization of bed net using structured questionnaire. A physical inspection of all bed nets in household was done and their condition recorded.

Result: Of 200 surveyed households 85% were owned at least insecticide treated net. 0f the total 366 bed net only 43.98% were in use and 56.02% misused. 83.5% of misused nets had not been opened and hanged. 19.89% of people residing in the survey households slept last night under a insecticide treated net before the survey.

Conclusion: Although the study household had awareness of insecticide treated net, there were a wide gap between possession and utilization of nets. Therefore, mass distribution of bed net should be accompanied with regular follow up on utilization at community level.

Keywords: Insecticide-treated net, Malaria, Coverage, Utilization, Misuse

Abstract 11: Repellent efficacy of DEET, MyggA, neem (*Azedirachta indica*) oil and chinaberry (*Melia azedarach*) oil against *Anopheles arabiensis* , the principal malaria vector in Ethiopia

Ephrem Abiy[1]*, Teshome Gebre-Michael[2], Meshesha Balkew[2] and Girmay Medhin[2]

[1] RTI International, [2] Addis Ababa, Addis Ababa University, Aklilu Lemma Institute of Pathobiology

Background: In Ethiopia, *Anopheles arabiensis* is the main vector responsible for the transmission of malaria in the country and its control mainly involves application of indoor residual spraying (IRS) and use of insecticide-treated bed nets (ITNs).

Objective: Although the role of repellents for reducing man-vector contact is documented in the literature, the response of *An. arabiensis* to repellents was not previously evaluated under field conditions in Ethiopia.

Method: The trial was conducted in Sodere village assessing the repellent activities of four repellents, of which, two of them were commercially available DEET (N, N-diethyl-1,3-methylbenzamide) and MyggA (p-methane diol) and the other two were laboratory- produced, 20% neem oil and 20% chinaberry oil. A 6 by 6 Latin square design was employed by involving six volunteers who received rotated treatments of repellents and the Ethiopian Niger seed, noog abyssinia (Guizotia abyssinia), and locally called as noog oil (diluents to the two plant oils). Each volunteer also served as control. Volunteers were positioned at a distance of 20–40 m from each other and each was treated with one of the repellents, Niger seed/noog/ oil or untreated. Landing mosquitoes were collected from dusk to down using tests tubes. The tests were done in three replicates.

Results: Both DEET and MyggA provided more than 96% protection. The mean protection time for DEET was 8 hrs while the time for MyggA was 6 hrs. Protection obtained from neem oil and chinaberry oil was almost similar (more than 70%), however, the complete protection time for neem was 3 hrs, while that of chinaberry oil was one hour.

Conclusion: The commercial products and laboratory-produced repellents can be utilized by individuals to avoid contact with *An. arabiensis* in Ethiopia.

Abstract 12: Evaluation of the Efficacy of DDT Indoor Residual Spraying and Long-Lasting Insecticidal Nets Against Insecticide Resistant Populations of Anopheles Arabiensis Patton (Diptera:Culicidae) From Ethiopia Using Experimental Huts

Abebe Asale[1, 4], Yehenew Getachew[1], Weriessaw Hailesilassie[2], Niko Speybroeck[3], Luc Duchateau[4] and Delenasaw Yewhalaw[1]

[1]Jimma University, [2] AA University, [3] University of Leuven, [4] Ghent University

Background: Indoor Residual Spraying (IRS) and Long-Lasting Insecticidal nets (LLINs) are major malaria vector control tools in Ethiopia. However, recent reports from different parts of the country showed that populations of Anopheles arabiensis, the principal malaria vector, have developed resistance to most families of insecticides recommended for public health use which may compromise the efficacy of both of these key vector control interventions. Thus, this study evaluated the efficacy of DDT IRS and LLINs against resistant populations of Anopheles arabiensis using experimental huts in Asendabo area, south-western Ethiopia.

Methods: The susceptibility status of populations of An. arabiensis was assessed using WHO test kits to DDT, deltamethrin, malathion, lambda-cyhalothrin, fenitrothion and bendiocarb. The efficacy of LLIN (PermaNet® 2.0), was evaluated using the WHO cone bioassay. Moreover, the effects of the observed resistance against malaria vector control interventions (DDT, IRS and LLINs) were assessed using experimental huts.

Results: The findings of this study revealed that populations of Anopheles arabiensis were resistant to DDT, deltamethrin, lambda-cyhalothrin and malathion with mortality rates of 1.3%, 18.8%, 36.3% and 72.5%, respectively but susceptible to fenitrothion and bendiocarb with mortality rates of 98.81% and 97.5%, respectively. The bio-efficacy test of LLIN (PermaNet® 2.0) against Anopheles arabiensis revealed that the mosquito population showed moderate knockdown (64%) and mortality (78%). Moreover, mosquito mortalities in DDT sprayed huts and in huts with LLINs were not significantly different (p > 0.05) from their respective controls.

Conclusion and Recommendation: The evaluation of the efficacy of DDT IRS and LLINs using experimental huts showed that both vector control tools had only low to moderate efficacy against An. arabiensis populations from Ethiopia. Despite DDT being replaced by carbamates for IRS, the low efficacy of LLINs against the resistant population of An. arabiensis is still a problem. Thus, there is a need for alternative vector control tools and implementation of appropriate insecticide resistance management strategies as part of integrated vector management by the national malaria control program.

Keywords: Anopheles arabiensis, Insecticide resistance, Experimental huts, LLINs, Ethiopia

Abstract 13: Study on the *In Vivo* Antimalarial Activity of Solvent Fractions of the Leaf of *Vernonia Amygdalina* against *Plasmodium Berghei* in Mice

Temesgen Bihonegn[1], Getinet Yimer[2], Mirutse Gidaye[3], Abebe Animut[3]

[1]Kombolcha College of Agriculture affiliated to Wollo University, [2] Addis Ababa University, College of Health Sciences, School of Medicine.[3] Addis Ababa University, Aklilu Lemma Institute of Path biology.

Background Malaria is one of the leading causes of morbidity and mortality in Ethiopia. The most important problem associated with the manegement of malaria are resistant to the most widely available, affordable and safest first line treatments**.**

Objective: To evaluate the *in vivo* antimalarial activity of solvent fractions of the leaves of *V. amygdalina* against *Plasmodium berghei* infection in mice using four day suppressive .

Methods: A total of 900 grams of coarsely powdered leaves were extracted with cold maceration in 80% methanol. A total of 90 grams hydroalcoholic crude extract of *V. amygdalina* was subjected to chloroform, butanol and aqueous fractions. For evaluating antiplasmodial activity of *V. amygdalina* , four day suppressive test was employed.

Results: Acute oral toxicity test showed that both the aqueous and hydroalcolic extracts and solvent fractions of the leaves of *V.amygdalina* revealed no mortality and signs of toxicities up to 2000mg/kg. All doses of crude extracts of *V. amygdalina* prolonged the survival time, shown prevention against weight loss and prevent PCV reduction in a dose dependent manner. The percentage suppression of chloroform fraction was 21.68%, 23.72% and 33.85 % at 100, 200 and 400mg/kg of the fraction, respectively. The 100 and 200 mg/kg of butanol fraction resulted in moderate anti-plasmodial activity (18.12%, and 21.03% %, respectively), followed by the 400 mg/kg (26.88%).

Conclusion: The results of the present study indicated that the *in vivo* administration of both extracts and solvent fractions of the leaf of *V. amygdalina* possess antimalarial activity and were capable of suppressing parasitemia.

 Recommendations: There is a need to advance the current status of *V. amygdalina* to an antimalarial lead drug level through isolation and characterization active antiplasmodial components in the extracts and solvent fractions.

Key words: Antimalarial activity, Four day suppressive test, *V. amygdalina*.

Abstract 14: Patients' perception and satisfaction on quality of laboratory malaria diagnostic service in Amhara Regional State, North West Ethiopia

 Agajie Likie Bogale

Background: The most effective strategies in the fight against malaria are to correctly diagnose and timely treat the illness. A diagnosis based on clinical symptoms alone is subjected to misuse of anti-malarial drugs, increased costs to the health services, patient dissatisfaction and also contributes to an increase in non-malaria morbidity and mortality. Among others, inappropriate perception and inadequate satisfaction of patients are significant challenges reported to affect the quality of laboratory malaria diagnostic services.

Methods: A facility-based, cross-sectional study was conducted from November to December 2013 among 300 patients. Their level of satisfaction was measured using both pre-tested structured and open ended questionnaires. A 5-point Likert scales and their weighted average

were used to categorize satisfaction level of the patients. Data were entered in Epi-Info version 3.5.3 and analysed using SPSS version 20. Chi-square test was used to see the association between the outcome variable and independent and the strength of the association was identified using odds ratio in the binary logistic regression. In addition the open ended questionnaire findings were coded and analysed thematically.

Results: Over half (52.6 %) of the patients were satisfied with the malaria diagnostic service with a 98.7 % response rate. The majority (89.3 %) of patients perceived they were well diagnosed in facing fever upon giving blood for laboratory malaria diagnosis within 30 min waiting time in most (62.5 %) of the patients. Ethnicity, residence, knowing malaria diagnosis after consulting clinician, and time period to receive malaria result were the independent predictors for patient satisfaction (p < 0.05). The open ended questionnaire responses also revealed providing precise laboratory result timely, availability of the right treatment, presence of health professionals performing the laboratory test upon request in the health facility were among the major enabling factors for patients' satisfaction.

Conclusion: The observed level of satisfaction in the current study though encouraging when compared with some previous studies conducted in eastern Ethiopia on general laboratory services, still it requires scale-up in the enhancement of malaria laboratory diagnostic service in the fight against malaria.

Abstract 15: Assesment of Ownership and Factors Affecting Utilization of Insecticide Treated Bed Nets in Dembecha Woreda, West Gojjam Zone, Ethiopia, 2014

Dawit Siraw (Mph) Advisor, Dr. Desalegn Dalecha (Md, Mph) Aau, Sph

Background: Malaria is a preventable and treatable mosquito-borne disease. Approximately 52 million people (68%) live in malaria risk areas in Ethiopia. Dembecha woreda annual report shows that malaria is the top leading cause of morbidity and mortality Assessment of factors related with bed net Ownership and utilization is not well understood. Observation and rumors of not using nets in a correct manner deserve close examination.The main objective of this study is to assess the ownership and factors affecting utilization of Insecticide Treated bed nets in Dembecha woreda, west gojjam zone, Ethiopia.

Methods: A Cross sectional study was used and interview was conducted using structured questionnaire to assess the ownership and factors affecting utilization of Insecticide Treated bed nets in Dembecha woreda 2014. Two kebeles from highly malarious stratum and two kebeles from medium malarious stratum based on burden of the disease were randomly selected for the study and

totally 4 kebeles were used. A total of 380 households were systematically selected from the study kebeles by using their respective household head name list which was obtained from kebele administration from four kebeles. The data was entered, cleaned, edited and analyzed using EPI info version 3.5.1 and SPSS version 16.

Results/Findings: Malaria was recognized as a major problem. Possession of at least one net was reported by 79.2% of the households but ever sleep under a net was (40.5%). Factors associated with net use were: being knowledgeable, getting health information about malaria and ITNs and education status. The odds of being knowledgeable was 3.0 higher (AOR= 3.04; 95% CI :(1.69-5.43), the odds of getting health information pertaining to malaria was 3.3 higher, (AOR= 3.33; 95%CI: (1.05-10.59), the odds of getting health information pertaining to bed net was 11 times higher, (AOR= 11.24; 95%CI: (5.107-24.75) and the odds of education status(grade 1-4) of the head was 2.82 times higher,(AOR= 2.82; 95%CI: (1.459-5.452) Nets however, were not always used for the intended purpose.

Conclusion and Recommendations: Selection of control measures, should take into consideration local situation. Once chosen as methods of prevention, mosquito net distribution should have proper guideline and local capacities for doing so should be strengthened.

Key words; Utilization, Insecticide treated bed net, Malaria

Abstract 16: Effect Of Health Education Focusing On School Communities And Religious Leaders On Community's Malaria Prevention Behaviors, Jimma Zone: A Result From Lots Quality Assurance Survey

Zewdie Birhanu[1], Lakew Abebe[1], Morankar Sudhakar[1], Gunawardena Dissanayake[2],

Guda Alemayehu[2]

[1]Jimma University, [2] United States Agency for International Development

Background: Promoting community's appropriate behavioral practices is a critical component of malaria prevention and control activities. This study assessed effect of malaria education through school communities and religious leaders on communities' malaria prevention and control behaviors in Jimma zone.

Methods: The data were obtained from a study conducted to promote communities behavioral practices on malaria prevention and control in five districts of Jimma Zone. The project was started in Jan 2014 and run for three years. As part of preparatory activities, baseline data were

collected in Jan 2014. The interventions included health education activities through school communities and religious leaders. To monitor progress on key indicators, Lots Quality Assurance survey was conducted in June 2015. In this report, we compared baseline indicators to results obtained from LQAS. The data were analyzed by SPSS 17.0 and STATA 12.0

Results: The study indicated that 64.2% of the target population had exposed to school based malaria education activities. On the other hand, nearly of the populations (54.7%) also received malaria related information through religious based health education. The interventions resulted in large improvements in community's knowledge, attitude and malaria prevention behaviors. Accordingly, mean knowledge and attitude score was increased by 6.8 and 7.1 respectively. Likewise, long lasting insecticide treated net use was increased from 38.0% to 62.0% (among households members); from 66.3% to 73.7 %(under five children); from 42.9% to 76.8% (pregnant women), and ratio of LLIN use to access was increased from 70.2% to 82.0% leading to narrowed behavioral failure gap in net use. On the other hand, seeking care within 24 hours after onset of fever was increased by 14.9% (from 19.8% to 34.7%). However, the result did not show improvement in rational use of anti-malaria drugs.

Conclusions and recommendations: Health education focusing on school communities and religious leaders improves community perceptions and behaviors on malaria preventive behaviors. However, the intervention did not show effect on proper use of anti-malaria drug use calling for attention and further investigations.

Keywords: Malaria, Seeking Care, LLIN, Behaviors, health education

Title: The economic burden of malaria and predictors of cost variability to rural households in South Central Ethiopia.

§Corresponding author

Email: alemayehu4all@gmail.com

Alemayehu Hailu[1,2,§], Bernt Lindtjørn[1], Wakgari Deressa[3], Taye Gari[1,4], Eskindir Loha[4], Bjarne Robberstad[1,5]

[1] Center for International Health, University of Bergen, Bergen, Norway

[2] Department of Reproductive Health and Health Service Management, School of Public Health,

Addis Ababa University, P.O.Box: 9086, Addis Ababa, Ethiopia, Tel: +251-115-157701, Fax: +251-115-517701

[3] Department of Preventive Medicine, School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia

[4] School of Public and Environmental Health, Hawassa University, Hawassa, Ethiopia

[5] Center for Interventional Sciences in Maternal and Child Health (CISMAC), University of Bergen, Bergen, Norway

Abstract

Background: While recognizing the recent achievement in the global fight against malaria, the disease remains a challenge to the malaria endemic countries in Africa. Beyond the huge health consequence, malaria imposes a heavy economic burden on individuals and the household's economy in malaria endemic countries. Policymakers need to recognize the economic burden of malaria to the household. But, the current evidence regarding the economic burden of malaria in Ethiopia is very scant. The aim of this study, therefore, was to estimate direct, indirect and the total cost of malaria to the rural households in Ethiopia.

Methods: This study is part of a large cluster randomized controlled trial of evaluation of combined implementation of malaria prevention interventions in Ethiopia. We employed an incidence-based, prospective costing, households' perspective approach. A total of 190 cases of malaria were identified from Primary Health Care Units from January–December 2015 in AdamiTullu Jido-Kombocha district in South-central Ethiopia. We collected the data by face-to-face interview with the head of the household on the 10th day after treatment was initiated. The data were analyzed using STATA, version 14. Non-parametric tests –Kruskall-Wallis and ManWhitney tests —were applied to compare the median costs across levels of household wealth status, health facility (health post and health center) and malaria species (Plasmodium. falciparum and Plasmodium vivax). Quintile (median) regressions were employed to predict factors associated with variability of median cost of malaria.

Result: The total median cost of malaria per episode to the household was US$5.06. The direct cost (US$2.39) accounted for 39.2% and the indirect (US$3.76) counterpart accounted for 60.8% of the total cost. Direct non-medical cost (median = US$1.56) is more than two times higher than direct medical cost (median = US$ 0.59). Mean diagnostic testing cost was USD$ 0.15. One hundred fifty eight of them (83 %) received the anti-malaria drug directly from the public facility where they were examined, while 32 (17%) of them only received the prescription because of unavailability of the drug at the primary health care units. The finding from quintile regression indicates that the household's economic status, duration of illness, and immediate treatment seeking behavior significantly influences the direct cost of malaria. On the other side, age of the patient and availability of the ant-malaria drug at the facility, significantly influence the indirect cost. Total cost was mainly significantly influenced by the availability of the anti-malaria drug at the facility. Both mean and median direct cost were significantly higher amongst the patients from the poorest households (CI = -0.155, P-value for Kruskal wallis and CI < 0.001). There was a statistically significant difference between both direct and indirect cost due to p. Falciparum and p. vivax (Mann-Whitney test P < 0.001).

Conclusion: The economic burden of malaria to the households in rural Ethiopia is substantial. Reducing malaria burden contributes to the economic welfare and poverty reduction. The national malaria program needs to recognize the burden, and identify mechanisms for ensuring that the poor have access to malaria treatment.

Declining Pattern of Malaria Cases in Jimma Town and its Suburbs: a six-year retrospective study

Endalew Zemene[1*], Estifanos Kebede[1], Teshome Degefa[1], Delenasaw Yewhalaw[1, 2]

[1]School of Medical Laboratory Sciences, Jimma University Institute of Health, Jimma University

[2]Tropical and Infectious Diseases Research Center, Jimma University

*Presenting author: endalew.zemene@ju.edu.et

Abstract

Background: Despite the perceived decline in the incidence of malaria cases in public health facilities in Jimma town, documented data comprising the trend of malaria in recent years is not available. The objective of this study was to assess the trend of malaria cases in Jimma Town and correlate the cases with meteorological variables.

Methods: Six-year (January 2010 to December 2015) records of patients seeking treatment for fever at public health facilities in Jimma Town were reviewed. Data on demographic and malaria diagnosis of the patients were retrieved from the records. Moreover, monthly meteorological factors of Jimma Town were obtained from Jimma Branch of the National Meteorology Agency, and correlated with the monthly malaria cases. Data were analysed using quasi-Poison regression model using the statistical software R.

Results: Over the six years, a total of 9,300 patients were diagnosed for malaria, of which 6,276 (67.5%) were microscopically-confirmed malaria cases and the remaining 3,024(32.5%) were diagnosed with malaria clinically. There was a significant decline in the trend of total malaria cases, and both vivax and falciparum malaria since 2010. *Plasmodium* v*ivax* was the predominant species (67% of all the microscopy-confirmed cases) recorded. Prevalence of microscopy-confirmed cases was significantly higher among males and older age group. Mean minimum monthly temperature showed significant correlation with malaria at one and two-month lag time, whereas mean monthly rainfall was significantly associated with monthly malaria cases at two-month lag time. Mean maximum temperature was significantly negatively correlated with malaria cases at two-month lag time.

Conclusion: A significant decline in malaria cases was recorded since 2010 in all the health facilities. *Plasmodium vivax* was the predominant *Plasmodium* species in the area. Control interventions should be intensified to sustain malaria control and to initiate elimination efforts in the area. A strategy should be in place to prevent relapse of vivax malaria in the area.

Key words: Malaria, Retrospective, climatic factors, Jimma Town, Ethiopia

Reducing indoor exposure to bite of vectors, and malaria transmission through screening houses in malaria hotspot villages in Arba Minch town, south-western Ethiopia: a randomized trial

Solomon Kinde Getawen[1], Fekadu Massebo[1] and Bernt Lindtjørn[2]

[1] Department of Biology, Arba Minch University, Arba Minch, Ethiopia

Email: solomonkinde@gmail.com

Email: fekadu.massebo@amu.edu.et

[2] Centre for International Health, University of Bergen, Bergen, Norway

Email: bernt.lindtjorn@cih.uib.no

Abstract

Background: House is the major site for malaria infection where most human-vector contact takes places. Hence, houses screening might reduce the risk of malaria infection by limiting house entry of vectors. This study was assessed the impact of screening doors and windows on indoor density, sporozoite and entomological inoculation rate (EIR) of malaria vectors, and on malaria transmission in Gebeya Dar and Georges sub-*Kebeles* (*Kebele*-smallest administrative unit in Ethiopia) of Arba Minch town, southwest Ethiopia.

Methods: Pre-and post-intervention mosquito collection was done by Center for Disease Control and Prevention (CDC) light traps. Pre-intervention mosquito sampling was done in 92 randomly selected houses twice per month from July-Dec 2015. The 92 households were randomized into control and intervention groups using the pre-intervention *Anopheles* mosquito data. The doors and windows of 46 houses were screened by wire-mesh. Post-intervention mosquito collection was conducted biweekly from February-April 2016. *Anopheles* mosquitoes were identified into species using a morphological key, and the circum-sporozoite proteins (CSPs) analysis was done using Enzyme-Linked Immuno-Sorbent Assay (ELISA). All the household members both in the intervention and control groups were screened for malaria parasite using a rapid diagnostic test. The insecticide susceptibility status of *Anopheles arabiensis* was conducted by collecting and rearing larvae and pupae from natural breeding habitats within the *sub-Kebeles*. A

Generalized Estimating Equations with a negative binomial distribution was used to see the impact of screening intervention. Probit analysis was employed to calculate the knock down time of *An. arabiensis.*

Results: House screening with wire-mesh reduced the indoor density of malaria vector *An. arabiensis* by 48% (statistically significant; p = 0.001). The impact of house screening intervention was substantially high (69%) on unfed (active host-seeking) *An. arabiensis* than other abdominal stages. *Plasmodium falciparum* CSP rate was 1.6% in houses screened with wire-mesh and 2.7 % in control houses. Screening doors and windows reduced the sporozoite rate of *An. arabiensis* by 41%, but the reduction was not statistically significant (p>0.05). Screening doors and windows reduced the EIR of *An. arabiensis* by 70%, and the risk of receiving infectious bites was 3.3 times higher in control houses compared to the screened houses. *Plasmodium falciparum* was the dominant parasite species identified in both human and malaria vector *An. arabiensis.* The bed-net use rate was similar in intervention and control groups. *Anopheles arabiensis* was resistant to deltamethrin (mortality rate of 75%), but highly susceptible to bendiocarb, propoxur, and malathion.

Conclusion: House screening intervention has played a substantial role by reducing the exposure to malaria vectors, and hence can be recommended as an important intervention that could be included in malaria vector control package.

Keywords: *Anopheles arabiensis*, entomological inoculation rate, house screening intervention, indoor vectors density, malaria transmission