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AIMS African Institute for Mathematical Sciences RWANDA

MALARIA TRANSLATIONAL RESEARCH WORKSHOP

MEETING REPORT

Date	22 - 26 January, 2024
Venue	Ma Campagne Resort, Rwamagana, Kigali
Collaborators	Rwanda Biomedical Centre (RBC), Centre for Impact Innovation and Capacity Building for Health Information and Nutrition (CIIC-HIN), and African Institute of atical Sciences (AIMS) Rwanda.
Funding Institution	The Bill and Melinda Gates Foundation (BMGF)

Background

The World Health Organisation (WHO) reported a staggering 249 million malaria cases and 608,000 malaria-related deaths globally in 2022, with a disproportionate 94% occurring in the African region. In Rwanda, concerted efforts by the Ministry of Health (MoH) and Rwanda Biomedical Center (RBC) have resulted in a significant decline in malaria incidence from 400 per 1000 in 2016 to 148 per 1000 in 2020. Building on this progress, the MoH and RBC have committed to reducing malaria morbidity and mortality by at least 50% of 2019 levels by 2024, as outlined in the 2020-2024 Malaria Strategic Plan (MSP). Central to this strategy is the strengthening of surveillance information and data utilization for informed decision-making at all levels.

Aligned with these objectives, the Malaria Modeling Africa (MamodAfrica) project, a collaboration between AIMS Rwanda, Université d'Abomey-Calavi, Benin, and CIIC-HIN Rwanda, seeks to leverage modeling techniques to support malaria interventions in Africa. Supported by funding from the Bill and Melinda Gates Foundation (BMGF), MamodAfrica aims

to establish a sustainable ecosystem of mathematical modelers, translational specialists, and decision-makers.

In Rwanda, in anticipation of the Multilateral Initiative on Malaria (MIM) society conference scheduled for April 2024, stakeholders were gearing up to showcase progress in malaria control alongside other African nations. MamodAfrica and MIM initiatives complement each other, providing opportunities to bridge the gap between academic modeling and the operational needs of National Malaria Control Programs (NMCPs) across the continent.

To further this agenda, the Malaria Translational Research Workshop, funded by BMGF, was convened in collaboration with CIIC-HIN, AIMS, and key stakeholders from Rwanda's NMCP. The workshop aimed to harness existing malaria-related data using mathematical and statistical techniques to assess the current status, epidemiology, and potential impact of interventions. Emphasizing a training approach, the workshop sought to equip Rwandan researchers and NMCP staff with the skills to effectively utilize data for translational research purposes, facilitating communication between NMCPs and research communities.

Under the theme of "Data for Impact in Malaria," the workshop aimed to collectively develop scientific abstracts for submission to MIM, fostering scientific exchange and collaboration between NMCPs, data scientists, and researchers worldwide. This collaborative effort underscores the importance of utilizing modeling techniques to inform evidence-based malaria control strategies and policy decisions.

Workshop Objectives

The overarching goal of the Translational Workshop on Malaria was to train researchers and NMCP staff on modeling techniques for malaria. Leveraging the collective expertise of data scientists, malaria researchers, junior researchers, and health practitioners from NMCPs, academia, research institutions, as well as funders in malaria programs, the workshop aimed to contribute significantly to the advancement and exchange of knowledge in mathematical modeling, malaria research and program implementation.

Specific Objectives

i. Catalog existing data sources to inform evidence-based decision-making in malaria control.

The workshop provided a platform for participants to understand the wealth of existing data related to malaria, from sources such as the HMIS-Health Management Information System (HMIS), electronic-Logistics Management Information System (e-LMIS), System d'Information Sanitaire at the Community level (SIS COM), as well as primary datasets.

ii. Provide participants with practical training in applying mathematical / statistical / spatial modeling techniques to existing data

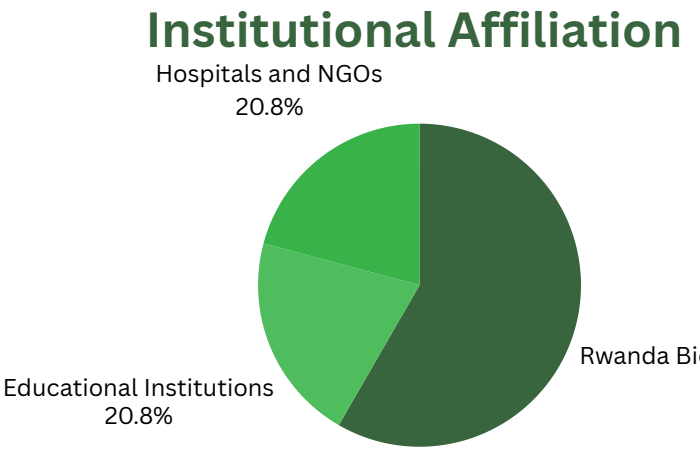
Through collaborative sessions with data scientists and group discussions, participants gained practical experience in using computational software and modeling data to draw conclusions about the status, epidemiology, and potential impact of interventions in malaria.

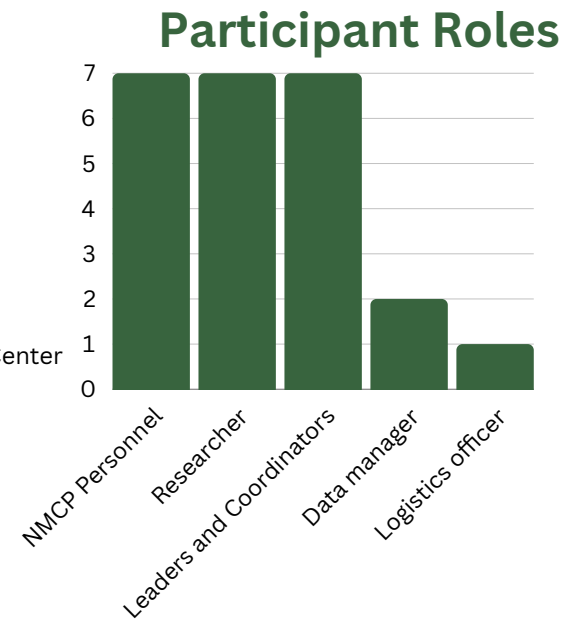
iii. Assist participants in transforming research ideas into conference-ready abstracts

Recognizing the importance of knowledge translation, the workshop offered hands-on guidance to participants in refining their research outputs into concise abstracts suitable for conference submissions. Facilitators engaged attendees in practical exercises aimed at condensing complex research findings into succinct abstracts. Through peer review and expert feedback, participants honed their skills in transforming draft reports, research papers, and theses into polished and conference-ready abstracts.

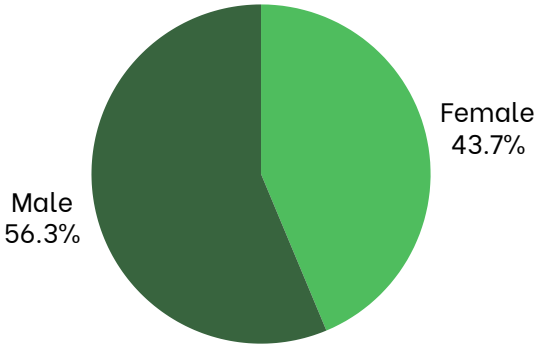
Workshop Description

A total of **24 participants** represented various organizations in the workshop, which sought to assemble a diverse cohort of professionals, all with a shared commitment to advancing malaria control efforts. During the 5-day workshop, participants engaged in a multifaceted learning experience aimed at enhancing their proficiency in modeling, data analysis and abstract-writing. The methodology was structured to provide participants with a comprehensive understanding of content as well as facilitate guided, practical exercises in data analysis and abstract writing to generate insightful results.





Participant gender breakdown



Agenda

Day 1: Introduction to Translational Research and Abstract Writing

Session 1: Understanding Modeling and Translational Research

- 09:00 AM–09:30 AM: Registration and Welcome Remarks
- 09:30 AM–10:30 AM: Introduction to Translational Research and Modeling: Concepts and Principles
- 10:30 AM–11:00 AM: Coffee/Tea Break

Session 2: Components of an Effective Abstract

- 11:00 AM–12:30 AM: Key Elements of a Translational Research Abstract
- 12:30 PM–01:30 PM: Lunch Break
- 02:00 PM–05:00 PM: Structuring Your Abstract: Title, Background, Methods, Results, Conclusion

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Day 2: Hands on exploration of datasets and data management

- 09:00 AM–12:15 PM: Formation of group based on suggested participant's interest and topics
- 12:30 PM–01:00 PM: Lunch Break
- 01:00 PM–2:30 PM: Group activity: analyzing datasets and formulating problem statements
- 02:35 PM–05:30 PM: Design of methodology by identifying appropriate models (with mentors' guidance)

Day 3: Mentor revision and modeling techniques

- 09:00 AM–12:30 PM: Individual activity: review and reflection on methodology based on mentor's feedback
- 12:30–1:30PM: Lunch

- 01:30 PM–03:30 PM: Group activity: data transformation and cleaning (Data scientists from RBC, CIIC-HIN and UR were present to support the research team)
- 3:30 PM–5:30 AM: Session on feature engineering

Day 4: Model application and performance evaluation

- 09:00 AM–12:30 AM: Application of selected models to real data, under mentor supervision
- 12:30-1:30 PM: Lunch
- 1:30 PM–5:30 PM: Group activity: evaluation of models using metric scales

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Day 5: Abstract Development

- 09:00 AM–11:30 PM: Incorporating results and implications of modeling analysis into the abstracts
- 11:30 AM -1:30PM: Mentor review and feedback
- 1:30-2:30 PM: Lunch
- 2:30-3:00 PM: Fine-tuning abstracts: clarity, precision, and conciseness
- 3:00-5:00 PM: Support on submission following the step-by-step guidelines for MIM
- 5:00 –5:30 PM: Summary and closing remarks.

Post-Workshop: Follow-Up and Submission Support

After the workshop, mentors continued to work with the workshop participants, leveraging technological tools to collaborate on improving and refining the abstracts until they were ready for submission.

Workshop Activities:

Topics Covered

1. Malaria Epidemiology Modelling & Surveillance
2. Vector Biology Control
3. Treatment & Community Case Management
4. Social Health Economics
5. Malaria Genomics
6. Drug Resistance
7. Diagnosis Reagents Development
8. Malaria control and Eradication
9. Capacity Building, Leadership and Governance

Data Sources

- **HMIS** (Health Management Information System)
- **E-LMIS** (Electronic Logistic Management Information System)
- **SIS COM** (Community Health Worker data)
- **IDSR** (electronic Infectious Disease Surveillance and Response)
- **Meteorological data**
- **National Reference Laboratory** malaria quality control data
- **Drone-based data**
- **Primary datasets**

Modeling Approaches

- Multiple linear regression
- Independent samples T-test
- Paired T-test analysis
- Inturrupted time series analysis
- Spatial analysis
- Mapping assessment
- Geographic Information System (GIS) analysis
- Principle component Analysis

Expert presentations, group discussions and peer review sessions focused on training attendees to use mathematical modeling on existing data sets to extract key findings relevant to malaria research.

- **Model Selection and Adaptation**: Facilitators assisted participants in selecting appropriate mathematical and statistical models for malaria modeling based on the specific context and data availability.
- **Data Analysis and Calibration**: Expert data scientists guided data analysis techniques and calibration methods to fit the chosen models to local epidemiological data. This step ensured that the models accurately represented the dynamics of malaria transmission in the target population.
- **Scenario Exploration**: The workshop supported participants in exploring various scenarios using mathematical/statistical models to assess the potential impact of interventions or environmental changes on malaria transmission.
- **Predictive Modeling**: The workshop helped participants develop predictive models to forecast malaria incidence based on factors like climate, population movement, and intervention strategies. These models can assist public health officials in allocating resources effectively and planning interventions proactively.

Highlights:

Regression models were used to analyze relationships between various factors and malaria outcomes, such as incidence rates or prevalence:

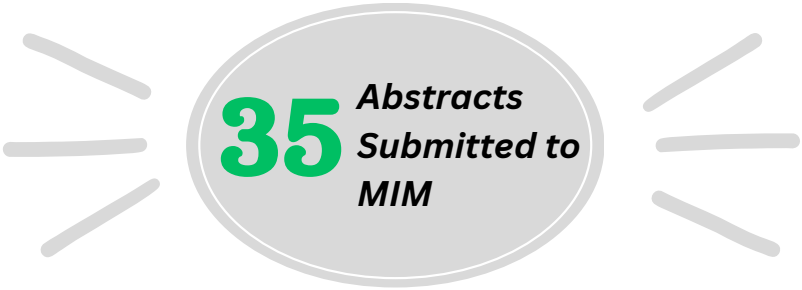
- Principle Component Analysis and Logistic Linear Regression Models were used to estimate the prevalence and distribution, as well as assess the misdiagnosis, of non-falciparum and mixed-species infections in malaria endemic regions.
- Multiple Linear Regression to study the correlation between climatic factors and malaria cases in Sentinel Sites in Rwanda
- Interrupted Time Series analysis to understand the impact of the “Malaria scorecard” interventions on Long-lasting insecticidal nets (LLINs) coverage among pregnant women

through in Rwanda
- Advanced statistical and epidemiological models were tested using Kappa test, and positive and negative predictive values to estimate sensitivity and specificity of new diagnosis tools for better clinical care in 2 sites (Musanze and Kigali)

Transmission Dynamics Models were used to understand how malaria spreads through a population.

- Geographic Information System (GIS) analysis was used to map malaria hotspots among high-risk groups in Rwanda, and identify targeted interventions.
- Spatial analysis to model cross border transmission of malaria among high risk populations.

Outcomes

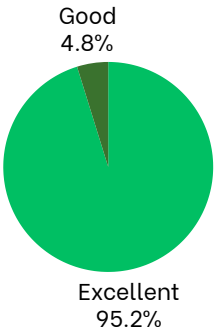


- **Enhanced capacity**: Participants developed proficiency in analyzing data, distilling key findings, and translating them into clear and impactful abstracts.
- **Building Capacity in Modeling**: Provided training on modeling methodologies to researchers and NMCP staff, enabling them to employ modeling approaches in assessing malaria epidemiology, intervention impact, and program planning.
- **Improved abstract quality**: Through peer review and expert feedback, participants refined their abstracts, ensuring alignment with conference themes and adherence to scientific standards.
- **Strengthened collaboration**: The workshop facilitated networking and collaboration among participants from diverse backgrounds, fostering interdisciplinary dialogue and knowledge exchange.
- **Empowered researcher**s: Attendees gained confidence and competence in abstract writing, equipping them to contribute meaningfully to the advancement of malaria research and program implementation.

Conclusion

Participant Satisfaction

The majority of participants rated the workshop as 'Excellent', highlighting its quality and favorable impressions surrounding it.



The Malaria Translational Research Workshop was a resounding success, specifically emphasizing the power of mathematical/statistical modeling in understanding and addressing complex issues in malaria research. The workshop successfully trained NMCP and health practitioners in modeling and culminated in the production of high-quality, theme-aligned abstracts that are enriched with the insights derived from modeling techniques. By harnessing the collective expertise and fostering collaboration among NMCP staff, malaria researchers, junior researchers, and health practitioners, the workshop has made significant strides in advancing knowledge and innovation in malaria research, malaria modeling and application of predictive models to improve programmatic efforts and policy decision making processes. The success of this workshop serves as a testament to the effectiveness of a collaborative, interdisciplinary approach that places modeling at the forefront of efforts to combat and understand malaria.