RESIDUAL MALARIA TRANSMISSION IN THAILAND:

Findings for Policy Makers – Draft Document

Summary

In the Greater Mekong Subregion (GMS), long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) are the primary methods of mosquito control. However, even where universal coverage of nets has been achieved and other recommended interventions, such as community-based primary healthcare, have been scaled up to the maximum level realistically achievable, low level malaria transmission persists. This is known as residual malaria transmission (RMT).

This study determined the magnitude and causes of RMT in two rural communities of Thailand and Viet Nam. This policy brief focuses on the research carried out in Thailand. In Thailand, three villages in Tak Province were chosen as the study sites. Despite having an LLIN coverage of 82%, Tak province had the highest malaria incidence in Thailand in 2014 (11.3 per 1000 population). Tha Song Yang had the highest case loads at district level, with an incidence of 46.2 per 1000 in 2014, 17.8 per 1000 in 2015; and 7.5 per 1000 in 2016 (Ministry of Public Health).[1]

The study has shown that universal LLIN usage has not been achieved at the community level in the study sites, with villagers not having enough LLINs to use in the village, as well as on the farms and in forests. Even if universal LLIN usage were achieved, however, risk of RMT could still remain. This is due to early evening and late morning biting from malaria mosquitoes when people are awake and not under their mosquito nets. Even with the use of nets during sleeping hours, the exposure to indoor biting mosquitoes is high, as there is a high proportion of biting that occurred during the sleeping time of 9 pm to 5 am. The malaria vectors were also shown to spend more time outdoors, feeding on animals rather than only humans. Their preference for cattle means that the mosquitoes were less likely to come into contact with, and be killed by, LLINs or IRS. There was also higher abundance of mosquito biting in forested ecological sites away from the village where people were less likely to be under the protection of nets. A number of policy recommendations were made, based on these findings.

Key findings:

- LLIN coverage was not adequate for key target groups in different sites.
- Net maintenance and treatment remained substandard.
- There was significant overlap between human activities and vector biting times; this was exacerbated by a gap in personal protection of vulnerable populations who were exposed to bites during the night when malaria mosquitoes were most active.
- There was a low malaria risk perception; mosquitoes were seen as less of a nuisance than they were in the past.

[1] Ministry of Public Health, accessed at http://mgis.ddc.moph.go.th

TDR For research on diseases of poverty
UNICEF • UNDP • World Bank • WHO

malaria consortium
disease control, better health

RESEARCH APPROACH

This study was conducted in the villages of Suan Oi, Pha Man and Komonae (Tha Song Yang District, Tak Province). These villages, situated in western Thailand on the border with Myanmar, have an abundance of forests, hills and streams, which provide optimal conditions for breeding of *Anopheles*. The research followed an 'ecohealth' framework, emphasising a transdisciplinary systems approach, and involved community participation. The disciplines involved in this study were:

1 *Sociology*

To find out more about villagers' patterns of movement and their behavioural practices, direct observations were conducted, as well as interviews and focus group discussions with risk groups. Risk groups – the forest-goers and mobile groups – were given GPS tracking devices to monitor their movements and to identify likely transmission spots.

Methods: Direct observation, tracking of forest-goers and mobile groups using GPS-enabled tracking devices, focus group discussions and in-depth interviews with those using the GPS devices.

3 *Epidemiology*

To determine the species of infection and key risk factors for infection, cross-sectional blood surveys of the study population were conducted. Historical data were also analysed to understand how transmission levels have changed over time. Risk factor analysis was carried out to determine which demographic groups were at a higher risk of getting malaria.

Methods: Passive case detection (PCD), cross-sectional prevalence surveys, and knowledge, attitudes and practices (KAP) surveys.

2 *Meteorology*

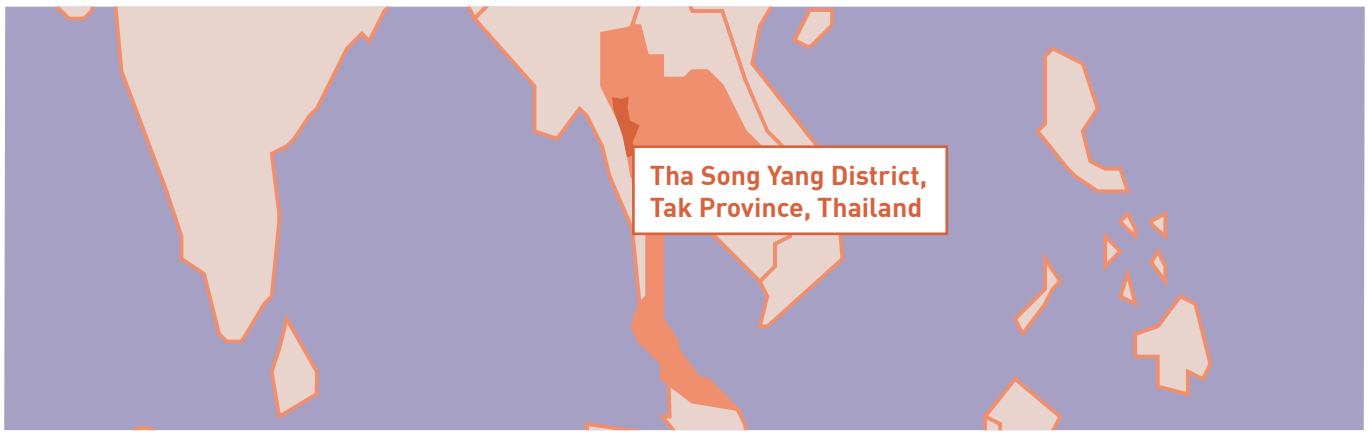
Data were collected on temperature, relative humidity and light intensity at the same time as the mosquito collections in each village site were undertaken. Rainfall estimates were also collected from national weather monitoring stations.

Methods: Temperature, relative humidity and light intensity were detemined using a weather data logger device.

4 *Entomology*

Field and laboratory studies were conducted to find out more about the malaria vectors, including mosquito species abundance, whether mosquitoes were infected with the malaria parasite, what time mosquitoes fed, and biting site (village, farm, forest). The researchers also determined whether mosquitoes fed on humans or animals, and whether they fed indoors or outdoors.

Methods: Human landing catch (village, farm hut, forest), baited cow catch (village), vector species identification based on morphology, *Plasmodium* infection determined using ELISA, an enzyme-linked test that detects and measures parasite antigens in mosquito tissues and body parts.



Full details of experiments carried out are available on:

www.vbd-environment.org

KEY RESULTS

1 *Universal LLIN coverage has not been achieved in the study sites*

RMT is the malaria transmission that remains after universal coverage of LLINs has been achieved. LLIN coverage figures are not reported at community level in local and national surveillance systems. This study showed that universal coverage had not been achieved at the community level in the study sites, and therefore not all of the malaria cases seen could be attributed to RMT. [1]

This was primarily caused by:

1. Not enough LLINs distributed to cover each family member, with LLINs not sized for family beds

2. Very limited to no use of mosquito nets in farm and forest sites, as the family did not have spare mosquito nets and/or mosquito nets were cumbersome to carry

3. LLINs unavailable in the village markets, and concern over impregnation of nets with insecticides

4. Substandard net maintenance and treatment, with villagers using damaged nets

NET USE ACROSS SITES

Village: Access to treated nets was approximately **80**% for all study villages. Approximately **80**% of adults used LLINs the previous night.

Farm: Approximately two thirds of of adults who stayed overnight on farm plots used a mosquito net. Nets were only used if village households had spare nets, which they could take to the farm sites.

Forest: Less than **10**% of forest-goers used a mosquito net.

2 *Other factors were also shown to contribute to malaria transmission*

This study also showed that even if every individual in the study site were to use an LLIN when asleep, malaria transmission risk could still occur. This would be due to a number of reasons, most notably:

Biting times of primary vector mosquitoes occur before and after human sleeping hours.

Biting was higher in forested farm hut locations where coverage and usage of nets was much lower, and not always possible because people sleep outdoors or work at night.

Mosquitoes displayed preference for outdoor feeding (exophagy) and animal feeding (zoophagy). By remaining outdoors and feeding on animals, the mosquitoes could avoid contact with the two most common mosquito control methods, LLINs and IRS.

[1] The evidence comes from our analysis which is summarized as "In two forested hamlets in Thailand, 33% to 67% of the early evening and later morning biting indoor mosquitoes are responsible for RMT when people are no longer sleeping and are outside of their LLINs.

POLICY IMPLICATIONS

1 *Personal vector control tools*

There was a high outdoor transmission risk and high transmission risk outside of sleeping hours, and in farm huts and forest sites. This limited the effectiveness of LLINs. Personal vector control tools are required to supplement LLINs that can protect before and after net use – before bedtime and after waking up, and during night time hours on the farm or in the forest. These need to be light-weight, durable and inexpensive.

POTENTIAL OPTIONS INCLUDE

treated long-sleeved clothing

insect repellent

light-weight mosquito hammocks

2 *Mosquito net distribution*

Increase and evaluate net distribution. Follow WHO guidance of one bednet for every two people, and take into account the need for extra nets at farm huts or dual residences. Conduct bed net attrition and durability through pre- and post- bed net distribution surveys.

3 *Increase awareness*

Increase awareness on the causes and risks of malaria and the need to maintain net use.

FURTHER RESEARCH

- **Identify target groups and site locations** most optimal for intervention that meet the definition of RMT and are most optimal for implementation of core interventions.
- **Conduct an intervention study** using LLINs and innovative new vector control approaches in places where the persistence of malaria transmission has moved from villages to farm plots and forests.
- **Mathematical modelling of transmission** in sites and testing of vector control tools.
- **Quantify RMT across wet and dry seasons** and construct a seasonal diary of the life of a forest worker or seasonal farmer in different transmission (or eco-epidemiological) settings.

About this project

This policy brief summarizes outcomes of the research project on *Residual Malaria Transmission in the Greater Mekong Subregion – Studies to examine its magnitude and identify its causes*. The principal investigator was Dr Jeffrey Hii, Senior Vector Control Specialist at Malaria Consortium Asia. Epidemiological data was provided from ICEMR-Asia study funded to Pennsylvania State University, USA, in collaboration with Mahidol Vivax Research Unit and in technical collaboration on vector study with Medical Entomology Department, Faculty of Tropical Medicine, Mahidol University; Queensland Institute Medical Research Berghofer (QIMR) and Bureau of Vector Borne Diseases, Ministry of Health Thailand.

This work was financially and technically supported by TDR, the Special Programme for Research and Training in Tropical Diseases. Technical support was also provided by the World Health Organization Global Malaria Programme. UK Aid also provided financial support.

TDR For research on diseases of poverty
UNICEF • UNDP • World Bank • WHO

malaria consortium
disease control, better health