Defining residual malaria transmission foci. Use of mixed-methods design in Tak, Thailand and Khanh Hoa, Vietnam

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Study aims

To investigate the magnitude and causes of residual malaria transmission (RMT) in selected settings in the Greater Mekong Subregion.

• Magnitude: how much is going on
  - how must is outdoor v indoor

• Causes: what is causing and impacting this RMT
  - epidemiological: species of infection, risk factors
  - entomological: vector species, biting time, biting site
  - social-behavioural: human movement, behaviour, practices
  - ecological/meteorological: ecological niches, climate
Study aims

Investigate contributing factors in three ecological niches

Where is the transmission taking place?
Study sites

Criteria:

- RMT: universal coverage of ITN/LLIN and maximal IRS coverage but ongoing transmission
- Villages with farming and forest activities

→ Two sites chosen in two different countries
→ Differing considerations for transmission
1 – Tak Province, Thailand

Tak province: Malaria incidence: 19 per 1000 population in 2014
Large migrant population, ethnic minority groups
Border-crossing and imported cases

LLIN coverage: 82% (province level)
(57,697 nets distributed to population of 103,855 2012-2015)

>90% target HH reached each year in district

Thai population, M1 and M2 cases in Tak Province:
Tha Song Yang, Tak, TH

Population: 138,000 residents; 27,000 houses

Highest malaria caseloads:
3,655 confirmed malaria cases in 2014 (≈20 per 1,000 pop)

<table>
<thead>
<tr>
<th>Village</th>
<th>Population</th>
<th>Malaria incidence, 2014</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suan Oi</td>
<td>531</td>
<td>36.5 per 1000</td>
<td>close to border, more urban</td>
</tr>
<tr>
<td>Pa Man</td>
<td>101</td>
<td></td>
<td>forested</td>
</tr>
<tr>
<td>Komonae</td>
<td>199</td>
<td></td>
<td>less urban</td>
</tr>
</tbody>
</table>
2 – Khanh Hoa, Vietnam

Annual parasite index (API) of 1.2 per 1000 in 2014

Population of 1.2 million

Predominantly Kinh and minority groups such as Cham Raglai, Hoa and Koho.

Forest cover > half of province area, and 16.7% of area is used for farming
2 – Son Thai, Khanh Vinh, Khanh Hoa, Vietnam

Khanh Vinh = highest caseloads in province
Son Thai = highest caseloads in district

Son Thai = 2,015 population
        436 households (two villages)

2014: ≈3 cases per 1,000 pop
2015: ≈2 cases per 1,000 pop

Image from: investinvietnam.vn/data/image/Khanh%20Hoa(1).jpg
RMT theoretical framework:

**Epidemiological**
- Prevalence/incidence
- Plasmodium species
- Immunological factors
  - Risk factors

**Entomological**
- Vector species composition
- Vector capacity
- Vector abundance
  - Biting times
- Anthropophagy
- Exophagy/endophagy

**Social-behavioural**
- Movement and mobility
- KAP, incl. use of malaria prevention
- Access to health services

**Ecological & Meteorological**
- Forest cover
- Breeding sites
- Temperature
- Rainfall

Universal LLIN and/or maximal IRS coverage
## Mixed methods approach

<table>
<thead>
<tr>
<th></th>
<th>Thailand</th>
<th>Vietnam</th>
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</thead>
<tbody>
<tr>
<td><strong>Epidemiology</strong></td>
<td></td>
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</tbody>
</table>
| i) Cross-sectional surveys | Ongoing by MVRU: blood surveys (May, Aug, Nov)  
KAP and net coverage survey (Oct) | Blood and KAP survey August - 700 participants |
| ii) PCD data analysis | VBDC                                                                         | Provincial, district and commune health departments |
| **Entomology**    |                                                                           |                                                                         |
| i) Human Landing Catch (village, farm hut, forest) | Village sites: monthly, June-Nov  
Farm/forest: 6 sites since Aug | Three collections July, Oct, Nov/Dec |
| ii) Bait cow catch |                                                                         |                                                                         |
| **Observational** |                                                                           |                                                                         |
| i) Transect walks | With entomology above                                                      | With entomology above                                                    |
| ii) HH net use    | With entomology above                                                      | With entomology above                                                    |
## Mixed methods approach

<table>
<thead>
<tr>
<th>GPS tracking</th>
<th>Thailand</th>
<th>Vietnam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tracking of forest and farm goers</strong></td>
<td>July-present, 25 participants completed</td>
<td>July-present, 39 participants completed</td>
</tr>
<tr>
<td>To i) analyse human movement, ii) identify sites for farm and forest mosquito collections</td>
<td>Aiming for 28 more</td>
<td>Continuing till end Nov</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Thailand</th>
<th>Vietnam</th>
</tr>
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<tbody>
<tr>
<td><strong>Focus group discussions, in-depth interviews</strong></td>
<td>8 FGDs and 8 IDIs completed Sept</td>
<td>---</td>
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</tbody>
</table>

### Figure 4: Agricultural calendar for rural Karen communities in the METF area. The above calendar gives general schedules for: a one-season rice paddy system, a corn (maize) farming system and commonly-collected forest products. Most rural villages in the METF area follow this basic calendar, though many schedules are more complex, including more major and minor crops. (Shoklo Malaria Elimination Task Force)
GPS tracking
Interesting findings so far:

**LLIN coverage not optimal**
- not completely fitting RMT definition
- Need for village level LLIN coverage data

**Transmission foci**
- TH = high abundance vectors in village, biting indoor and outdoor; *An dirus, minimus* and *maculatus* all found in forest
- VN = no evidence of exposure in village; *An. dirus* in farm and forest

**Early/late biting**
- TH = evidence of early evening biting (including indoor), before people under nets
- VN = evidence of biting in later morning, after people have woken up

**Human movement & behaviour**
- TH = high amount of border crossing, though limited distance of travel
- VN = varying distance of travel
- “dual residence” – village-farm hut
Near-infrared Spectroscopy (NIRS)

- Age grading *An. gambiae* in Tanzania
Next steps

Conclude field and lab work

Identify transmission foci and gaps in protection

Nominate target groups and site locations most optimal for intervention to reduce RMT
Thank you...

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- National Institute Malariology, Parasitology and Entomology (NIMPE), Vietnam
- Queensland Institute Medical Research (QIMR)

Collaborators:

- BVBD
- VBDU Tha Song Yang
- Provincial, district and commune health departments in Khanh Hoa, VN