The impact of treated eave ribbons in reducing malaria transmission: a mathematical modelling perspective

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Background

Main malaria vectors; *An. funestus* and *An. arabiensis*

*An. funestus*
- Anthropophilic; Endophilic

*An. arabiensis*
- Zoophilic; exophilic

Challenges
- Resistance to insecticides
- Outdoor & early hours biting
Supplementary tools are needed

Eave ribbons

• Treated with spatial repellent
• Repel mosquitoes
• Kills mosquitoes

• Provide protection indoor and outdoor in peri domestic areas
Overall aims

• Assessing the impact eave ribbon + ITNs on transmissions mediated by *An. funestus* and *An. arabiensis*.

• Impact of the interventions on combined transmissions mediated by *An. arabiensis* and *An. funestus*.
<table>
<thead>
<tr>
<th></th>
<th>Anopheles arabiensis</th>
<th>Anopheles funestus s.l.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of mosquitoes collected by CDC Light Trap (Jan 2015 to Jan 2016)</td>
<td>20135</td>
<td>4759</td>
</tr>
<tr>
<td>Total number of trap nights</td>
<td>1152</td>
<td>1152</td>
</tr>
<tr>
<td>Biting rate per night</td>
<td>17.48</td>
<td>4.13</td>
</tr>
<tr>
<td>Relative efficiency (CDC-LT) relative to HLC (Derived from Okumu et al 2008)</td>
<td>0.3</td>
<td>0.68</td>
</tr>
<tr>
<td>Corrected biting rate</td>
<td>58.26</td>
<td>6.08</td>
</tr>
<tr>
<td>Total number of mosquitoes analysed for Plasmodium falciparum circumsporozoite protein (CSP)</td>
<td>20135</td>
<td>4759</td>
</tr>
<tr>
<td>Total number of sporozoite positive mosquitoes</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Sporozoite rate</td>
<td>0.0002</td>
<td>0.0053</td>
</tr>
<tr>
<td>Annual EIR (Adjusted)**</td>
<td>4.22</td>
<td>11.65</td>
</tr>
<tr>
<td>% EIR Contribution (Adjusted)**</td>
<td>26.61%</td>
<td>73.39%</td>
</tr>
<tr>
<td>Annual EIR (not adjusted)</td>
<td>1.27</td>
<td>7.92</td>
</tr>
<tr>
<td>% EIR Contribution (not adjusted)</td>
<td>13.79%</td>
<td>86.21%</td>
</tr>
</tbody>
</table>

Kaindoa et al. (2017)
Methods

• VCOM was adapted and extended

• It describes mosquito life and feeding cycle
\[ S_{EB, ITN} = (1 - r_{EB})(1 - r_{ITN}) \]

Diagram with nodes:
- \( r_{EB} \)
- \( d_{EB} \)
- \( r_{ITN} \)
- \( d_{ITN} \)
Methods

1. Extraction of parameters

- Focused on studies conducted in Kilombero valley
- Other parameters were drawn from other studies conducted elsewhere
Methods

2. Simulating the impact of eave ribbon for the transmission mediated by *An. funestus* and *An. arabiensis* separately

- Different coverages (0% - 100%) when combined with 80% ITNs (baseline usage)
- Outcome measure was entomological inoculation rate (EIR)
- EIR – number of infectious bites per person per time
- EIR < 1, considered the point for malaria interruption

3. Simulating the impacts of the interventions for the combined transmission by *An. funestus* and *An. arabiensis*

- EIR as output measure
Results

Impact of combining eave ribbons & ITNs

An. arabiensis

An. funestus
Results

Impact of eave ribbons + ITNs on the combined transmissions

High coverage level (~60%) needed to reduce EIR to below 1
Conclusion

• New tools are needed to complement ITNs for successful malaria control.

• For *An. funestus*, eave ribbon and ITNs is the best combination

• For the combined transmission, higher coverage of the interventions are required though in reality is difficult to achieve.
Acknowledgement

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