Results from impact evaluations of IRS and PBO ITNs: Ethiopia and Sierra Leone

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With an increasing number of vector control tools available for use alone or in combination, national malaria programs (NMPs) need timely, local evidence to guide vector control product choice and deployment decisions.

With support from PMI Evolve, NMPs in Ethiopia and Sierra Leone conducted retrospective impact evaluations to understand the relative impact of different combinations of vector control interventions on epidemiological and entomological outcomes.

- **Ethiopia:** PBO ITNs alone vs. Standard Pyrethroid ITNs + pirimiphos-methyl-based IRS

- **Sierra Leone:** PBO ITNs alone vs. PBO ITNs + clothianidin-based IRS
ETHIOPIA | Study Design

Kebeles assigned to intervention arms using an open-label, stratified block-cluster randomized trial approach.

### Study Design

<table>
<thead>
<tr>
<th>Control variables</th>
<th>Epidemiological outcomes</th>
<th>Entomological outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention arm, time since intervention, precipitation, enhanced vegetation index (EVI), temperature</td>
<td>Routinely-reported confirmed malaria cases (all-ages)</td>
<td>Vector density per trap; indoor resting density</td>
</tr>
</tbody>
</table>

### Study Period

- **Epidemiological study period**
  - Sept-Dec 2019
  - Sept-Dec 2020
  - Sept-Dec 2021
  - Sept-Dec 2022

- **Entomological study period**
  - Sept-Dec 2021-2022

### Modeling Approach

- Negative binomial mixed effects models

### Model

- Negative binomial mixed effects models
**ETHIOPIA | Results**

**Epidemiological Outcomes**

<table>
<thead>
<tr>
<th>Overall pre- vs. post-intervention</th>
<th>↓ 53.6% *</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-72.9%, -29.8%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2 vs. Year 1 post-intervention</th>
<th>↓ 5.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-34.3%, 47.2%)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Year 2 vs. Year 1 post-intervention</th>
<th>↑ 98.1% *</th>
</tr>
</thead>
<tbody>
<tr>
<td>(49.5%, 167.3%)</td>
<td></td>
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</tbody>
</table>

No significant differences between intervention arms.

**Entomological Outcomes**

**Indoor Resting Density**

- Year 2 vs. Year 1 post-intervention: ↓ 71.1% *
  - IRR=0.29
  - 95%CI=0.21-0.40

- Year 2 vs. Year 1 post-intervention: ↓ 63.5% *
  - IRR=0.48
  - 95%CI=0.37-0.51

- Year 2 vs. Year 1 post-intervention: ↓ 51.6% *
  - IRR=0.78
  - 95%CI=0.69-0.89

Significantly greater decrease in the IRS + Standard ITN arm

**Vector Density per Trap**

- Year 2 vs. Year 1 post-intervention: ↓ 21.6% *
  - IRR=0.78
  - 95%CI=0.69-0.89

Significantly greater decrease in the IRS + Standard ITN arm

*Statistically significant
**Primary outcome**
- Routinely-reported all-ages confirmed malaria cases
- Human biting rate; indoor resting density

**Study period**
- Epidemiological: May 2017 – Apr 2023
- Entomological: Jul 2020 – Apr 2021 ; Jul 2022 – Apr 2022

**Modeling approach**
- Negative binomial mixed effects models

**Control variables**
- Intervention arm, time since intervention, non-malaria outpatient attendance, community health worker (CHW) reporting
- Intervention arm, time since intervention, precipitation, EVI, temperature, transmission season, collection location (HBR only)

**Beds per 100 population**
- 5

**Epidemiological study period**
- May 2017 - Apr 2018
- May 2018 - Apr 2019
- May 2019 - Apr 2020
- May 2020 - Apr 2021
- May 2021 - Apr 2022
- May 2022 - Apr 2023

**Entomological study period**
- May 2018 - Apr 2019
- May 2019 - Apr 2020
- May 2020 - Apr 2021
- May 2021 - Apr 2022
- May 2022 - Apr 2023
### SIERRA LEONE | Results

#### Entomological outcomes

<table>
<thead>
<tr>
<th>Overall Post-Intervention Changes Compared to Baseline</th>
<th>Year-to-Year Annual Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 post-ITN/Pre-IRS</td>
<td>Year 2 post-ITN/Year 1 post-IRS</td>
</tr>
<tr>
<td><strong>% Change (95% CI)</strong></td>
<td><strong>% Change (95% CI)</strong></td>
</tr>
<tr>
<td>PBO ITNs only</td>
<td>-32.0% * (-33.2%, -30.0%)</td>
</tr>
<tr>
<td>IRS + PBO ITNs</td>
<td>-28.4% * (-29.6%, -27.2%)</td>
</tr>
</tbody>
</table>

#### Interpretation

- **Small but greater reduction** in PBO ITN only areas (Pre-IRS)
- **No difference** in change between intervention arms
- **Small but greater reduction** in PBO ITN only areas

*Statistically significant

#### Epidemiological outcomes

- **Human biting rate**: 10% greater reduction in IRS + PBO ITN areas compared to PBO ITN only areas (IRR: 0.90, 95% CI: 0.82-0.99)

#### Entomological outcomes

**Comparing Year 1 post-ITN/Pre-IRS versus Year 2 post-ITN/Year 1 post-IRS**

**Indoor resting density**: No significant difference in reductions between intervention arms (IRR: 0.95, 95% CI: 0.75-1.21)
Discussion and Limitations

Key Findings

- Both intervention arms were associated with **reduced malaria cases overall** in Ethiopia, although the effect of PBO ITNs appeared to wane in the second year post-distribution.
- There was **no significant overall difference** in impact between deploying PBO ITNs alone compared to alongside annual IRS in Sierra Leone.
  - Greater declines in relative impact in the PBO ITN only arm in the 3rd year post-ITN distribution suggest co-deployment with IRS may sustain vector control impact as ITN durability declines.

Using routine data to estimate intervention impact

- Bias in malaria incidence estimates based on routine data can arise from changes in care-seeking, differences in access to parasitological diagnosis, and incomplete registration of patients. However, these biases would not be expected to vary in association with the interventions of interest.
- Routine data are an important source of longitudinal data and can effectively be used to evaluate the impact of new vector control tools.
Thank you to our partners and collaborators

**Ethiopia**
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Bahir Dar University
Jimma University
PMI
PMI Evolve Project

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**Sierra Leone**
National Malaria Control Program
PMI
PMI Evolve Project

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Thank You!