Webinar: Evaluating the Impact of IRS and ITNs: Lessons from PMI VectorLink

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9:00am Eastern Time

Moderator

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Panelists

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Agenda

• Background
• Overview of Evaluation Portfolio
• Country Evaluation Deep Dives
• Evaluation Findings Across PMI VectorLink
• Lessons Learned & Looking Forward
• Q&A
Background

• Remarkable progress in reducing malaria morbidity and mortality has been made over the past two decades.

• Core vector control interventions—indoor residual spraying (IRS) and insecticide-treated nets (ITNs)—have contributed significantly to this progress.

• However, progress has stalled worldwide amid a myriad of threats, such as resistance to insecticides used in IRS and on ITNs and changes in mosquito biting behavior.

Source: World Malaria Report 2022
PMI VectorLink | Overview

- **Years**: 2017-2023
- **Where We’ve Worked**: 25 countries in sub-Saharan Africa, as well as Cambodia & Colombia
- **Project Goals**:
  - Equip countries to plan and implement safe, cost-effective, and sustainable vector control interventions.
  - Strengthen capacity of country governments to make data-driven procurement decisions and target interventions sub-nationally.
  - Inform global malaria best practices, guidelines, and policies.
  - Promote gender equity in all facets of planning and implementation.
• Better inform vector control decisions and support efficient use of resources.
• Develop strategies to mitigate the spread of insecticide resistance.
• Facilitate effective use of the expanded toolbox for malaria vector control.
PMI VectorLink | Evaluation Overview

• 12 vector control evaluations initiated in 9 countries.
  – 7 evaluations were completed under VectorLink (5 on IRS, 2 on ITNs)
  – 5 evaluations will be completed by 2025 under PMI Evolve

• These evaluations use:
  – Routine HMIS data
  – Routine entomological data
  – IRS & ITN program coverage data
  – Geospatial meteorological data
  – Population estimates
Key evaluation questions:

1. What was the **epidemiological impact** of the vector control intervention?

2. When data was available, what was the **entomological impact** of the intervention?

3. How did that **impact compare** to the impact of alternative vector control interventions?

<table>
<thead>
<tr>
<th>Country</th>
<th>Evaluation Focus</th>
<th>Completion Date</th>
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<tbody>
<tr>
<td>Burkina Faso</td>
<td>IRS (2018-2021)</td>
<td>2022</td>
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<td>Côte d’Ivoire</td>
<td>IRS (2020-2021)</td>
<td>2022</td>
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<td>IRS + Standard ITNs vs. PBO ITNs (2021)</td>
<td>Early 2024*</td>
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<td>Liberia</td>
<td>IG2 ITNs (2021)</td>
<td>Early 2024*</td>
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<td>Madagascar</td>
<td>IRS (2017-2020)</td>
<td>2021</td>
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<td>Malawi</td>
<td>IRS vs. IG2, RG, &amp; PBO ITNs (2021)</td>
<td>Mid 2024*</td>
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<tr>
<td>Mali</td>
<td>IRS (2017-2019)</td>
<td>2020</td>
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<td>IG2 ITNs vs. Standard ITNs (2020)</td>
<td>2022</td>
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<td>Nigeria</td>
<td>PBO ITNs vs. Standard ITNs (2019)</td>
<td>2022</td>
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<td>IG2 ITNs vs. PBO ITNs (2022)</td>
<td>Late 2025*</td>
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<td>Sierra Leone</td>
<td>IRS + PBO ITNs vs. PBO ITNs (2021)</td>
<td>Early 2024*</td>
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*Evaluation is ongoing and will be completed under PMI Evolve*
Leveraging Routine Data

• Randomized controlled trials provide highest quality of evidence for impact but are costly and are only completed in a few countries.

• Quality and availability of routine malaria case data has greatly improved in recent years.

• Leveraging routine health systems data, entomological data, and vector control program data provides national malaria programs (NMPs) with an alternative to evaluate new & existing interventions in their own setting, at a lower cost, and at a more granular level.
EVALUATION DEEP DIVE:

EVALUATION OF CLOTHIANIDIN-BASED IRS IN CÔTE D’IVOIRE
Côte d’Ivoire | Context

- PMI VectorLink carried out **clothianidin-based IRS campaigns** in 2020 and 2021 in the districts **Sakassou** and **Nassian**.

- Malaria prevalence in children <5 years in the study districts ranged from **28.0% to 46.0%** in 2016 (MIS 2016).

- **Confirmed vector resistance to pyrethroids** has been detected by PMI VectorLink entomological monitoring.

- Mass distribution of **standard pyrethroid ITNs** was conducted in all the study districts in 2017 and 2021.

- An IRS impact evaluation was introduced to measure the effectiveness of IRS and to help inform future vector control decisions in Côte d’Ivoire.
For this evaluation, teams collected data directly from registers at health facilities, which resulted in high-quality data.

Given the considerable resources required to collect data in the field, this approach may not be widely feasible for other vector control impact evaluations.

However, this experience demonstrates the potential benefits to be reaped from strengthening routine health system data reporting and management.

<table>
<thead>
<tr>
<th>Benefits of using routine data</th>
<th>Disadvantages of using routine data</th>
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<tbody>
<tr>
<td>• Frequent reporting</td>
<td>• Data quality: completeness and updating are not always optimal.</td>
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<tr>
<td>• Measures actual program performance</td>
<td>• Limited use of data.</td>
</tr>
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<td>• Tracking of costs</td>
<td>• Data from health facilities not representative of the general population.</td>
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<tr>
<td>• Done by those who are directly involved in the program</td>
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</table>
What was the impact of the 2020 and 2021 IRS campaigns on malaria cases in Nassian & Sakassou?

**Evaluation period**

- **September 2018 to April 2022**
  - Pre-IRS: September 2018 to August 2020 (24 months)
  - Post-IRS 2020: September 2020 to August 2021 (12 months)
  - Post-IRS 2021: September 2021 to April 2022 (8 months)

**Geography**

- **IRS districts and control districts**
  - Sakassou and Nassian (IRS)
  - Béoumi and Dabakala (control)

**Outcome measure**

- **All-ages malaria cases** confirmed by rapid diagnostic test (RDT) or microscopy, adjusted by health facility catchment population

**Data collection**

- Data collected **directly from consultation registers** at the **94 health facilities** in the study districts.

Agent using mobile data collection tool in a health facility.
Collecting data directly from health facilities resulted in high data completeness enabling 90.8% of the data to be included in the analysis.

A decrease in confirmed cases was observed in 2020 across IRS and control districts, which corresponds with a period of RDT stockouts.

After the 2021 IRS campaign, malaria incidence diminished visibly in IRS districts compared to control districts.
Côte d’Ivoire | Interrupted Time Series Model Results

Over the 12 months following the 2020 campaign:

- Estimated 10,988 (95%CI=5,694-18,188) malaria cases averted.
- 15.9% reduction compared to if IRS were not implemented.

Over the 8 months following the 2021 campaign:

- Estimated 14,170 (95%CI=13,133-15,025) malaria cases averted.
- 24.7% reduction compared to if IRS were not implemented.

The decrease in malaria case incidence was significantly greater in IRS districts than in control districts after both campaigns.
Côte d’Ivoire | Conclusions

• This observational study presents evidence of a significant impact of IRS to reduce malaria case incidence over two consecutive years of implementation.

• Among the first to demonstrate a positive epidemiologic impact of clothianidin-based IRS.

• By collecting data directly from health facility registers stakeholders had a higher level of confidence in the quality of the data used in this study.
Significance of the evaluation

- IRS is a core vector control intervention which had not previously been implemented in Côte d’Ivoire. It was important to assess its impact locally, outside of the existing literature.

- The evaluation results confirmed that IRS is an effective strategy. The most useful elements of the evaluation results are the reductions in malaria cases and the number of cases averted due to IRS.

Use of evaluation results

- Despite the positive impact of IRS in Nassian and Sakassou, IRS was discontinued after 2022 due to insufficient resources.

- However, the results have been used to document and support the implementation of IRS at sites supported by private companies under public-private partnerships (PPPs).

Future vector control in Nassian and Sakassou

- A mass distribution campaign of IG2 ITNs in both districts was launched in July 2023 as part of the contingency plan following IRS withdrawal.

- Nassian will also receive SMC from 2024 to 2026.
EVALUATION DEEP DIVE:

EVALUATION OF INTERCEPTOR® G2 (IG2) ITNS IN MALI
Mali | Context

- Malaria is one of the leading public health challenges in Mali, with nearly 3 million reported cases annually
- Sikasso region:
  - Highest malaria prevalence among children <5 years (2018 DHS)
  - Confirmed pyrethroid resistance
- Seasonal malaria chemoprevention is implemented nationwide
- In July 2020, NMCP distributed:
  - Interceptor® G2 (IG2 ITNs): alpha-cypermethrin + chlorfenapyr
  - Yorkool® standard pyrethroid ITNs: deltamethrin
- An ITN impact evaluation was conducted to assess the impact of the IG2 ITNs compared to standard ITNs
**Mali | Evaluation Overview**

*What is the impact of *Interceptor® G2 ITNs* compared to *standard pyrethroid ITNs* in Sikasso Region?*

### Evaluation Period

- **August 2018 – July 2022**
  - **Before ITNs:** August 2018 – July 2020
  - **Mass distribution campaign:** July 2020
  - **After ITNs:** August 2020 – July 2022

### Sikasso Region

- **IG2 ITN Districts (4):** Kadiolo, Selingue, Yanfolila, Yorosso
- **Standard Pyrethroid ITN Districts (6):** Bougouni, Kignan, Kolondieba, Koutiala, Niena, Sikasso

### Outcome Measure

- **Confirmed malaria cases** and official population catchments per *aire de santé* via *Mali HMIS*
Comparing malaria case incidence before and after ITN distribution:

- **IG2 ITN**: 28% decrease*
- **Std. ITN**: 2% decrease*

25%* greater decrease in IG2 ITN areas compared to standard ITN areas

*Statistically significant difference
Comparing malaria case incidence:

**Year 1 Post vs Pre-Distribution**
- IG2 ITN: 33% decrease*  
- Std ITN: 12% decrease*

**Year 2 Post vs Pre-Distribution**
- IG2 ITN: 22% decrease*  
- Std ITN: 8% increase*  

*Statistically significant difference
Mali | Cases averted

Two years after ITN distribution

248,616 (89 161 - 465 608) additional cases averted
171 (61-320) additional cases averted per 1,000 residents
with IG2 ITNs compared to standard ITNs
Mali | Insecticide Resistance Monitoring

High-intensity resistance to pyrethroids

Some resistance to chlorfenapyr (IG2 ITNs) at 72 hours

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Collection Period</th>
<th>Intensity</th>
<th>Kadiolo</th>
<th>Selingue</th>
<th>Yanfolila</th>
<th>Std. Pyrethroid ITN Bougoni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrethroids</td>
<td>June - October 2018</td>
<td>1x</td>
<td>24%</td>
<td>36%</td>
<td>26%</td>
<td>76%</td>
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<td>5x</td>
<td>75%</td>
<td>54%</td>
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<td>10x</td>
<td>91%</td>
<td>73%</td>
<td>92%</td>
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<tr>
<td></td>
<td>June - October 2019</td>
<td>1x</td>
<td>16%</td>
<td>2%</td>
<td>22%</td>
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<td>27%</td>
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<td>71%</td>
<td>73%</td>
<td>77%</td>
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<td></td>
<td>June - October 2020</td>
<td>1x</td>
<td>21%</td>
<td>20%</td>
<td>2%</td>
<td>22%</td>
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<td>5x</td>
<td>86%</td>
<td>89%</td>
<td>85%</td>
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<td>10x</td>
<td>98%</td>
<td>98%</td>
<td>100%</td>
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<tr>
<td></td>
<td>June - October 2021</td>
<td>1x</td>
<td>50%</td>
<td>18%</td>
<td>47%</td>
<td>47%</td>
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<td>2%</td>
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<thead>
<tr>
<th>Insecticide</th>
<th>Collection Period</th>
<th>Time of mortality</th>
<th>Kadiolo</th>
<th>Selingue</th>
<th>Yanfolila</th>
<th>Std. Pyrethroid ITN Bougoni</th>
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<tbody>
<tr>
<td>Chlorfenapyr</td>
<td>June - October 2019</td>
<td>72 hrs</td>
<td>97%</td>
<td>93%</td>
<td>93%</td>
<td>93%</td>
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<tr>
<td></td>
<td>June - October 2020</td>
<td>72 hrs</td>
<td>100%</td>
<td>88%</td>
<td>78%</td>
<td>78%</td>
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<tr>
<td></td>
<td>June - October 2021</td>
<td>72 hrs</td>
<td>100%</td>
<td>100%</td>
<td>92%</td>
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Susceptibility Status

- ≥98% Mortality
- 90-97% Mortality
- <90% Mortality
Mali | Conclusions

- Reduction in malaria case incidence after ITN distribution in both IG2 ITN and standard pyrethroid ITN areas.
- Greater reduction in incidence in the IG2 ITN compared to the standard ITN group.
- In second year after distribution:
  - Increase in incidence in standard ITN areas
  - IG2 ITNs had a smaller reduction than first year, possibly due to insecticide resistance to pyrethroids & chlorfenapyr
  - Additional information is needed on durability and long-term use of the new nets
These results:

- Reinforce the NMCP's decision to distribute IG2 ITNs during the 2023 mass campaign. Particularly in regions:
  - Where malaria is widespread.
  - Have already received this type of ITN during the 2020 campaign.
  - Where IRS has recently been withdrawn.
- Reinforce the need to continue monitoring chlorfenapyr resistance.
- Demonstrate the value of using routine data to support decision-making at the national level.
- Serve as basis for Global Fund grant application for 2024 and future PMI Malaria Operational Plans (MOPs).
- Serve as an advocacy tool with authorities and partners for the extension of IG2 ITN distribution (campaign and routine) in all districts with high malaria transmission.
EVALUATION FINDINGS BY COUNTRY
• **Intervention**: 3 non-pyrethroid IRS campaigns in combination with SMC & ITNs

• **Location**:  
  - Boucle du Mouhoun region: Solenzo & Nouna  
  - South West region: Kampti & Gaoua

• **Period**: 2016-2022

• **Design**: Interrupted time series (ITS) with comparison

• **Impact**:  
  - ↓32% decrease in incidence in Solenzo (sudano-Sahelian climate) after 2018 campaign only; **no effect** after 2020 & 2021 campaigns  
  - ↓36-38% decline in incidence in Kampti (tropical climate) after each of the three campaigns

• **Conclusion**: Findings suggest impact of IRS may differ significantly by climate & may have higher impact in areas with low ITN use.

*2019 IRS campaign was not included in this study due to a health sector strike in 2019 that disrupted routine data reporting.*
• **Intervention**: 3-5 non-pyrethroid IRS campaigns (# of campaigns varied by district)

• **Location**: Benishangul Gumuz & Gambela regions

• **Period**: 2015-2019

• **Design**: Dose-Response

• **Impact**:
  - ↓ **7.2%** decrease in incidence for every ten-percentage-point increase in the percent of population protected by IRS
  - Each coverage group (e.g., 71-80%, 81-90%, etc.) showed statistically significant lower malaria case incidence when compared to the prior coverage group.

• **Conclusion**: Programs should aim to achieve the highest level of coverage feasible.
• **Intervention**: 4 non-pyrethroid IRS campaigns
• **Location**: 9 districts received IRS; 76 districts did not
• **Period**: 2016-2021
• **Design**: Counterfactual
• **Impact**:
  – ↓30.3% decrease in incidence under a no IRS counterfactual scenario 12 months post-campaign
  – A third year of IRS reduced malaria cases 30.9% more than one year
• **Conclusion**: Non-pyrethroid IRS substantially reduced malaria incidence and sustained implementation of over 3 years provided additional benefits
Key Findings | Mali

- **Intervention**: 3 non-pyrethroid IRS campaigns
- **Location**: 4 districts in Mopti region
- **Period**: 2016-2019
- **Design**: Difference-in-Difference
- **Impact**:
  - ↓ **32% greater decrease** in incidence among children <5 years in IRS areas in the 2017 high transmission period
  - ↓ **16-26% crude greater decrease** in all-age incidence after 2017-2019 campaigns, but no significant change after adjusting for covariates
- **Conclusions**: IRS was associated with a significant decrease in incidence among children <5 years after the 2017 IRS campaign but not among the entire population or in other years.

*Asterisks indicate significant decrease, p<0.05*
Key Findings | Nigeria

- **Intervention**: PBO ITNs
- **Location**: Ebonyi State (PBO ITNs, epi/ento), Cross River State (standard ITNs, epi only)
- **Period**: 2017-2021
- **Design**: ITS with comparison (epi); Pre/post (ento)
- **Impact**:
  - **↓ 47% decrease** in incidence compared to if no ITNs distributed in Ebonyi; **↑ 29% increase** in Cross River
  - **↓ 72% decrease** in human biting rate
  - **↓ 73% decrease** in indoor resting density
- **Conclusion**: Positive epidemiological and entomological impact of the first PBO ITN campaign in Nigeria in areas where PBO is able to restore susceptibility to pyrethroids.
Newer IRS and ITN products with non-pyrethroid insecticides were effective at reducing malaria burden and entomological indicators of malaria transmission in settings of confirmed pyrethroid resistance.

Dual-AI and PBO ITNs had a greater epidemiological impact compared to standard pyrethroid-only ITNs.

The impact of IRS may differ significantly by climate-related transmission setting and patterns of ITN use.

Sustained implementation of IRS over multiple years and higher levels of IRS coverage may provide additional benefits.
LESSONS LEARNED & LOOKING FORWARD
Lessons Learned & Areas for Improvement

1. Integration and use of routine health systems data within observational study designs offers NMPs an opportunity to conduct vector control evaluations with existing data, at a lower cost.
   - Continuing to strengthen health systems data will be crucial. Data collection activities can help improve confidence in results but are costly.
   - Population denominators for calculating malaria case incidence are critical but hard to come by.

2. Collaboration with national programs and other stakeholders throughout the evaluation is essential.
   - Ensure all high priority questions are being incorporated into the study design and are geared to answer specific policy questions.
   - Timing of analyses aligns with when results are needed for project planning & procurement decisions.

3. Study results need to be presented in a way that is actionable and digestible by a wider audience.
Ongoing Evaluations

• As challenges continue to emerge, continuing to conduct vector control impact evaluations will be critical.
• PMI VectorLink initiated 5 additional evaluations that will be completed under PMI Evolve:
  - IRS + PBO ITNs vs. PBO ITNs only in Sierra Leone
  - IG2 ITNs in Liberia
  - PBO ITNs vs. IRS + Standard ITNs in Ethiopia
  - PBO and IG2 ITNs in Nigeria
  - IRS vs. IG2, RG, or PBO ITNs in Malawi
Evidence Gaps

• Future evaluations should consider:
  – What is the epidemiological and entomological impact of complementary vector control tools, such as larval source management (LSM)?
  – What combinations of vector control tools are most effective in reducing malaria burden? And is there a differential impact of these combinations between high burden, low burden, and pre-elimination settings?
  – Which interventions or combinations of interventions are the most cost-effective?
Conclusions

• Evaluations conducted in collaboration with NMPs found a positive impact of different vector control interventions across multiple countries:
  – New types IRS & ITN products are effective at reducing malaria burden.
  – Products were effective in settings of confirmed pyrethroid resistance.
  – Newer ITNs more effective than standard ITNs.

• PMI Evolve is prepared to work with local research institutions on future impact evaluations
  – Build upon lessons learned under PMI VectorLink.
  – Strengthen NMPs & research institution collaboration to answer critical questions and highlight findings.
  – Continue to evaluate impact and inform future procurement & sub-national targeting decisions.
• **Journal Article:**

• **Technical Brief:** Evaluating the Impact of Vector Control Interventions | Results from the PMI VectorLink Project

• **PMI Technical Document:** Vector Control Integrated Data Analytics & Visualization Best Practices Guide

• **PMI VectorLink Evaluation Case Studies:**
  - Leveraging Routine Data to Drive Targeting of New Vector Control Interventions in Malawi
  - Making the Case for Using New Insecticide-Treated Nets in Mali
  - Evaluating the Epidemiological and Entomological Impact of Nigeria’s First PBO ITN Campaign