Webinar: Evaluating the Impact of IRS and ITNs: Lessons from PMI VectorLink Wednesday, August 23, 2023 9:00am Eastern Time

Moderator



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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 insecticidetreated 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.



PMI VectorLink | Overview

- <u>Years</u>: 2017-2023
- <u>Where We've Worked</u>: 25 countries in sub-Saharan Africa, as well as Cambodia & Colombia

Project Goals:

- Equip countries to plan and implement safe, costeffective, 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.



PMI VectorLink | Integrated Data Analytics & Visualization

- 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



Evaluation Objectives & Portfolio

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?

Country	Evaluation Focus	Completion Date	
Burkina Faso	IRS (2018-2021)	2022	
Côte d'Ivoire	IRS (2020-2021)	2022	
Ethionia	IRS (2015-2019)	2020	
стпоріа	IRS + Standard ITNs vs. PBO ITNs (2021)	Early 2024*	
Liberia	IG2 ITNs (2021)		
Madagascar	IRS (2017-2020)	2021	
Malawi	vi IRS vs. IG2, RG, & PBO ITNs (2021)		
	IRS (2017-2019)	2020	
	IG2 ITNs vs. Standard ITNs (2020)	2022	
Nicoria	PBO ITNs vs. Standard ITNs (2019)	2022	
муета	IG2 ITNs vs. PBO ITNs (2022)	Late 2025*	
Sierra Leone	ra Leone IRS + PBO ITNs vs. PBO ITNs (2021)		

*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.



Côte d'Ivoire | Using Routine Data for evaluations

- 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.

Benefits of using routine data	Disadvantages of using routine data			
 Frequent reporting Measures actual program performance Tracking of costs Done by those who are directly involved in the program 	 Data quality: completeness and updating are not always optimal. Limited use of data. Data from health facilities not representative of the general population. 			

Côte d'Ivoire | Overview

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) 	Evaluation period	IRS 2020 IRS 2021
Geography	IRS districts and control districts • Sakassou and Nassian (IRS) • Béoumi and Dabakala (control)	Baseline period 24 months	d Post-IRS 2020 Post-IRS 2021 12 months 8 months
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	e data collection tool in a health facility.

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Côte d'Ivoire | Results



Spray coverage (structures sprayed / structures found)



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.

High population and spray coverage (>85%) achieved in IRS campaigns in 2020 and 2021.



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.



Côte d'Ivoire | Data for decision-making

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): alphacypermethrin + 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?



Mali | Impact of 2020 ITN Campaigns

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



Mali | Impact by Year

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*



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

					IG2 ITN		Std. Pyrethroid ITN
	Insecticide	Collection Period	Intensity	Kadiolo	Selingue	Yanfolila	Bougoni
		June - October 2018	1x	24%	36%		28%
Ligh intensity resistance	Alpha-cypermethrin		5x	75%	54%		75%
rign-intensity resistance			10x	91%	75%		92%
		June - October 2019	1x	16%		2%	22%
to pyrethroids		June - October 2020	1x	27%	20%		10%
	Deltamethrin	June - October 2021	1x		38%		34%
			5x		73%		77%
			10x		71%		85%
		June - October 2018	1x	21%	67%		78%
Some resistance to			5x	86%	89%		91%
			10x	98%	98%		96%
chlorfenanyr (IG2 ITNs)		June - October 2019	1x	50%	60%	18%	47%
		June - October 2020	1x	2%	62%		16%
at 72 hours		June - October 2021	1X		36%		25%
al 12 110015			5X		97%		71%
			10x		100%		/1%
			Time of				
	Insecticide	Collection Period	mortality				
	msecticide	lune - October 2019	72 hrs	97%		92%	
	Chlorfenanyr	June - October 2019	72 ms	100%	00%	3370	79%
	споненару	June - October 2020	72 hrs	100%	100%		92%
		June - October 2021	121113		10070		3270

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



Mali | Data for Decision-Making

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



Key Findings | Burkina Faso

- 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:
 - J32% decrease in incidence in Solenzo (sudano-Sahelian climate) after 2018 campaign only; no so effect after 2020 & 2021 campaigns
 - J36-38% 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.

Key Findings | Ethiopia

- 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 tenpercentage-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.



Estimated Difference in Incidence by % Population Protected

Key Findings | Madagascar

- Intervention: 4 non-pyrethroid IRS campaigns
- Location: 9 districts received IRS; 76 districts did not
- Period: 2016-2021
- Design: Counterfactual
- Impact:
 - J 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

Incidence rate ratio (IRR) results describing associated between RDT-confirmed malaria cases and (a) IRS status 0-6 or 7-12 months after campaign and (b) IRS exposure in the 12 months after consecutive IRS campaigns



Key Findings | Mali

- Intervention: 3 non-pyrethroid IRS campaigns
- Location: 4 districts in Mopti region
- Period: 2016-2019
- **Design**: Difference-in-Difference
- Impact:
 - J 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.

All ages





*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
 - 172% decrease in human biting rate
 - 173% 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.





Key Findings | Completed IRS & ITN Evaluations

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.



Resources

- Journal Article:
 - Burnett, SM (2023). Process and methodological considerations for observational analyses of vector control interventions in sub-Saharan Africa using routine malaria data. The American Journal of Tropical Medicine and Hygiene.
 - Hilton, ER (2023). Using routine health data to evaluate the impact of indoor residual spraying on malaria transmission in Madagascar. BMJ Global Health.
- 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



Thank You!







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