President's Malaria Initiative

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Africa Indoor Residual Spraying Project
AIRS

Preliminary Results: The Effect on Malaria Burden after a Change in Insecticide for Indoor Residual Spraying in Zimbabwe

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Background

This study is intended to assess if using organophosphates (OPs) in indoor residual spraying (IRS) has an effect on the number of confirmed malaria cases at health facilities (HFs). OPs are substantially more costly, roughly ten times more expensive than pyrethroid (PY) insecticides ($2.5 compared to $23.5). Thus, as programs shift to more expensive insecticide to mitigate resistance, the number of beneficiaries protected by IRS is dependent on the type of insecticide used.

Objective

Identify an association between a change in insecticide used in IRS and the number of confirmed malaria cases at selected HFs.

Table 1. Group name, type and description for comparison analysis

No.	Group Name	Type	Description
1	Known resistance, switch to OPs in 2014/15	Intervention	Four districts in Manicaland. Mutare and Mutasa had measured resistance to PYs and carbamates. No susceptibility testing was done in the other two districts, but mosquitoes are suspected of having developed resistance because the districts have similar ecological settings to Mutare.
2	Other Manicaland	Comparison	Other districts in Manicaland, where no susceptibility testing was done. Spraying PYs and DDT
3	Mashonland Central comparison areas	Comparison	This province is most similar in ecology to Manicaland (which contains the 2 groups above). No susceptibility testing was done in Bindura, Guruve, Mazowe, and Shamva sprayed with PYs in all years, and no susceptibility testing was done. Centenary, Mbire, and Mt. Darwin sprayed DDT, no tests. *Rushinga District, also in Mashonaland Central, had susceptibility testing, and showed no resistance; thus it is included in group 5.*
4	Districts with known resistance, spraying same insecticide	Comparison	Susceptibility testing indicated PY resistance in Sanyati District in Mashonaland West province and in Chiredzi in Masvingo Province. Note: these two districts are in different ecological zones than Manicaland.
5	District with no resistance, spraying same insecticide	Comparison	Rushinga District in Mashonaland Central had susceptibility testing but no detected resistance. Mutoko District in Mashonaland East province also had susceptibility testing but no detected resistance.

Note 1: All districts had IRS, case management, last LLIN distribution in 2010, except Guruve, Shamva, Sanyati (distribution in 2012).
Note 2: The predominant vector in Manicaland is *An funestus*, while *An gambiae* is the vector in the rest of the provinces, and that is why the resistance data was extrapolated beyond test sites.

Methods

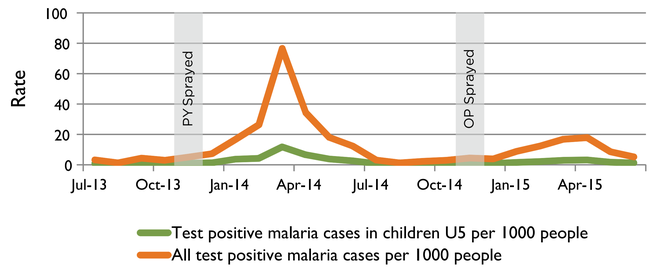
We used data from Zimbabwe's HMIS that is housed in DHIS2 to conduct the assessment. Data was collected from four districts where IRS operations are supported by the President's Malaria Initiative (PMI) and compared to using PY insecticides in government-sprayed districts. Overall, the data includes records from HFs in 18 studied districts. We ran unadjusted proportion tests and negative binomial regressions to determine significance of risk difference and risk ratios, respectively. Because of the high level of missing data before July 2013, these months are not included in the analyses; only the data for the time period from July 2013 to June 2015 is used in the analysis.

Results

Analysis 1.

The number of confirmed malaria cases in health facilities in the four intervention districts in 2013-2014 (PYs) and 2014-2015 (OPs).

Figure 1: The number of test positive cases per 1,000 people diagnosed at HFs in the four intervention districts, by month and age category



- **Figure 1.** Results show a marked drop in the incidence of test positive cases in all ages associated with the change from PYs to OPs in the four PMI-supported intervention districts.

Table 2: The average number of test positive cases per month (per 1,000 people) diagnosed at HFs in the four intervention districts, by period and age category

Period	Age group	PY (2014)	OP (2015)	Unadjusted Incident Rate Ratio (IRR)		
				Mean	95% CI	p-value
January-June (high transmission)	U5s	5.4	2.1	0.39	0.22 to 0.68	0.001**
	All	30.6	11.5	0.38	0.22 to 0.66	0.001**
February-April (peak transmission)	U5s	7.5	2.7	0.36	0.17 to 0.78	0.01*
	All	45.6	15.6	0.34	0.17 to 0.71	0.004**

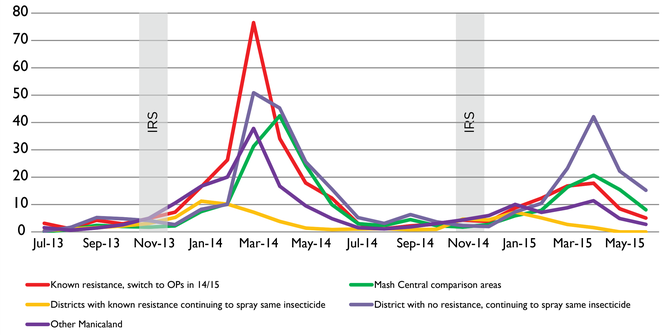
* $p < 0.05$; ** $p < 0.01$

- **Table 2.** Unadjusted results present a potential case for IRS with OP insecticide having an effect on malaria burden in these four districts. On average, in high transmission, the incidence rate of test positive cases per 1,000 people in 2015 was 38% of what it was in the same period in 2014 for all ages.

Analysis 2.

The number of confirmed malaria cases in HFs in 4 intervention districts in 2013- 14 (PYs) and 2014-15 (OPs) to 14 other districts

Figure 2. The number of test positive cases per 1,000 people diagnosed at health facilities, by comparison group, month and all ages



- **Figure 2:** The overall incidence rate was lower in 2015 than in 2014, but decreases were greater in districts that changed to OPs (from a higher rate in 2014). Other areas with known resistance had very low incidence rates in both years, while districts with no resistance using the same insecticide had higher rates in both years with minimal decrease in malaria incidence reported to HFs in 2015.

Table 3. The number of test positive cases per 1,000 people diagnosed at health, by comparison category, period, and age category

Area	For January to June high transmission period				For February to April peak transmission period			
	2013/14	2014/15	Risk difference	Unadjusted IRR	2013/14	2014/15	Risk difference	Unadjusted IRR
All ages								
Known resistance, switch to OPs in 14/15	**30.6**	**11.5**	**19.1***	**0.38****	**45.6**	**15.6**	**30.0***	**0.34****
Other Manicaland	17.6	7.5	10.1*	0.43**	24.8	9.1	15.7*	0.37*
Mash Central comparison areas	21.0	12.4	8.6*	0.59*	28.0	15.0	13.0	0.54*
Districts with known resistance using same insecticide	5.8	2.8	3.0	0.48	7.0	3.1	3.9	0.45
District with no resistance, using same insecticide	26.0	20.1	5.9	0.77	35.4	25.2	10.2	0.71
Children under 5 years of age								
Known resistance, switch to OPs in 14/15	**5.4**	**2.1**	**3.3***	**0.39****	**7.5**	**2.7**	**4.8**	**0.36***
Other Manicaland	3.0	1.2	1.8*	0.40**	4.1	1.4	2.7*	0.34*
Mash Central comparison areas	3.2	2.1	1.1	0.66	4.0	2.5	1.5	0.62
Districts with known resistance using same insecticide	0.8	0.3	0.4	0.45*	1.0	0.4	0.5	0.44
District with no resistance, using same insecticide	3.3	2.7	0.7	0.79	4.3	3.1	1.3	0.71

The IRR is uniformly lower in the four intervention districts in 2015 (except for *Other Manicaland* in children under 5 years for the peak transmission season). However, overall, it is fairly similar to *Other Manicaland* results. The risk difference is similarly greater in the districts that switched to OPs in 2015, indicating greater reduction in incidence associated with the switch to OPs, but this is, in part, a function of the high incidence in the 2014 transmission season. The incidence rate in 2015 is similar in the districts that switched to OPs in 2014/15 to many of the comparison areas.

Limitations

- These are preliminary unadjusted results and do not control for other factors (i.e., other malaria interventions, individual districts, data reporting, month of peak season, etc.) that may confound the incidence of reported cases of confirmed malaria.
- Health facility and district/provincial/ national level staff reported validating the data, but AIRS did not participate in or have evidence of any data verification activities.

Conclusions

- Results indicate a decline in malaria burden reported by HFs within both the four OP (intervention) districts and in the comparison districts from 2014 to 2015. However, the greatest decline was observed in the four intervention districts.
- More complex statistical data analysis is needed to measure if a change in insecticide to OPs for IRS does, in fact, have an effect on malaria burden at HFs. With this, we need to control for other factors that could affect our results (i.e., other malaria interventions, etc.)
  - We could also calculate the proportion of cases tested for malaria with positive results and compare those to the raw figures listed here as IRRs.
- We found missing data from more than 50% of HFs dating back from September 2013, and even worse reporting rates for the rest of 2013. Thus, we used data from 2014 and 2015 only.
  - Since IRS started implementation in all intervention and comparison districts before 2014, it is therefore difficult to establish time trends within and across our groups before 2014.

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