

# Insecticide resistance status of *Anopheles gambiae* complex in Ondo and Anambra states, Nigeria

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Continuous surveillance of malaria vectors' resistance to public health insecticides is vital for effective malaria control interventions

## Introduction

Insecticide resistance undermines the effectiveness of vector control measures, posing a significant challenge to malaria control efforts. Insufficient local data on insecticide resistance in Nigeria hampers malaria control strategies and may result in the procurement of ineffective tools. Insecticide-treated nets (ITNs) containing alpha-cypermethrin and piperonyl butoxide (PBO) can be effective for malaria control in areas with pyrethroid resistance. Malaria Consortium distributed ITNs containing alpha-cypermethrin and PBO during campaigns conducted in December 2021 and August 2022 in Ondo and Anambra states, respectively. Our study aimed to assess insecticide resistance status and genetic markers of target-site resistance in *Anopheles gambiae* s.l. populations.

## Methods

- The study sites in Ondo state were selected to represent two ecological zones: humid forest and derived savanna.
- *Anopheles gambiae* s.l. larvae and pupae were collected from all selected sites and reared to the adult stage.
- Baseline resistance data were collected in February 2021, two months after the campaign in Ondo state, and in August 2022, just before the campaign in Anambra state.
- A second round survey in Ondo state was conducted in September 2023, approximately 18 months after the baseline, to assess any changes in resistance levels.
- The CDC bottle bioassay method was used to assess resistance against various insecticides.
- Resistance intensity was determined by exposing resistant mosquitoes to two (2x) and five times (5x) the discriminating concentration.
- Synergist bioassays were conducted to assess the involvement of mono-oxygenases in the recorded resistance.

## Results

### Ondo state

- Resistance to alpha-cypermethrin was recorded in the forest zone (Figure 1), but complete susceptibility was restored upon pre-exposure to PBO.
- Deltamethrin resistance was observed in the forest zone at baseline (Figure 1), but no resistance was recorded in the second round.
- Resistance to permethrin was observed across all sites in the second round. Full susceptibility was restored upon pre-exposure to PBO, except in the forest zone (Figure 2).
- Susceptibility to alpha-cypermethrin, deltamethrin, lambda-cyhalothrin, bendiocarb and propoxur were recorded in round two across all sites.
- Intensity assays showed resistance to permethrin at two times, but not at five times the discriminating concentration.
- *Anopheles arabiensis* was the dominant species followed by *Anopheles coluzzii*.
- High frequencies of the L1014F and L1014S (*kdr*) resistance genes were observed especially in *An. arabiensis*.
- The G119S mutation was rare.

### Anambra state

- Possible resistance to alpha-cypermethrin was observed in Awka North site (Figure 3), but susceptibility was restored upon pre-exposure to PBO.
- The vectors were fully susceptible to deltamethrin and lambda-cyhalothrin across all sites.
- Resistance to permethrin was observed across all sites (Figure 3), but susceptibility was restored upon pre-exposure to PBO.
- No resistance to chlorfenapyr was detected in the sites where tests were carried out.
- High frequencies of the L1014F mutation were observed. The L1014S gene frequencies were low.
- G119S mutations were rare.

## Conclusion

Alpha-cypermethrin resistance was recorded in Ondo state at baseline and possible resistance was observed in Anambra state, but full susceptibility was restored after pre-exposure to PBO. Permethrin resistance in *An. gambiae* s.l. was widespread in both states. Pre-exposure PBO restored susceptibility to permethrin, except in the forest zone of Ondo State where partial restoration was observed, indicating potential additional resistance mechanisms. No resistance was detected against bendiocarb, propoxur and chlorfenapyr. The findings confirmed that distribution of ITNs with alpha-cypermethrin and PBO was appropriate in both states.

Figure 1. Baseline tests (pyrethroids) in Ondo state

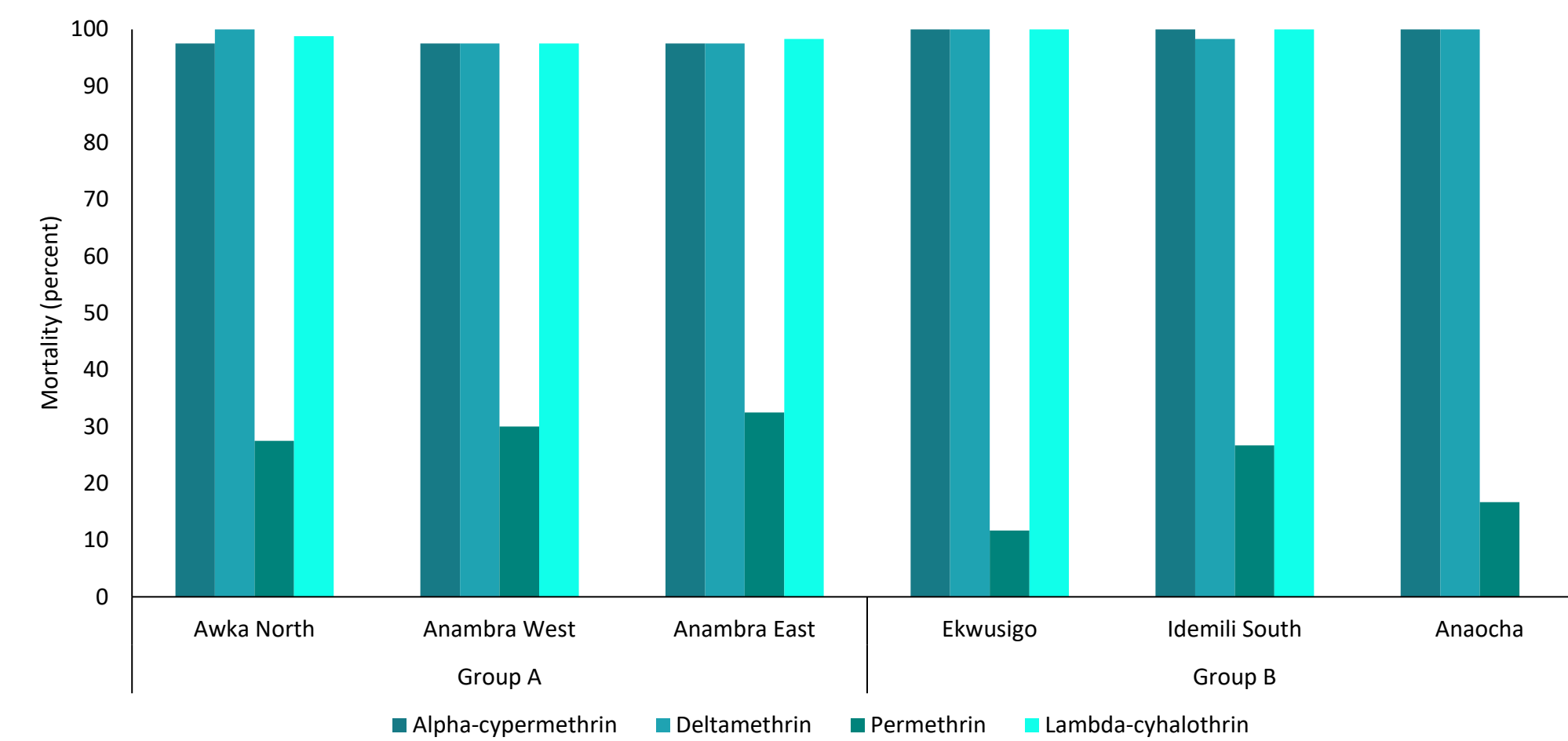


Figure 2. Baseline tests (pyrethroids + PBO) in Ondo state

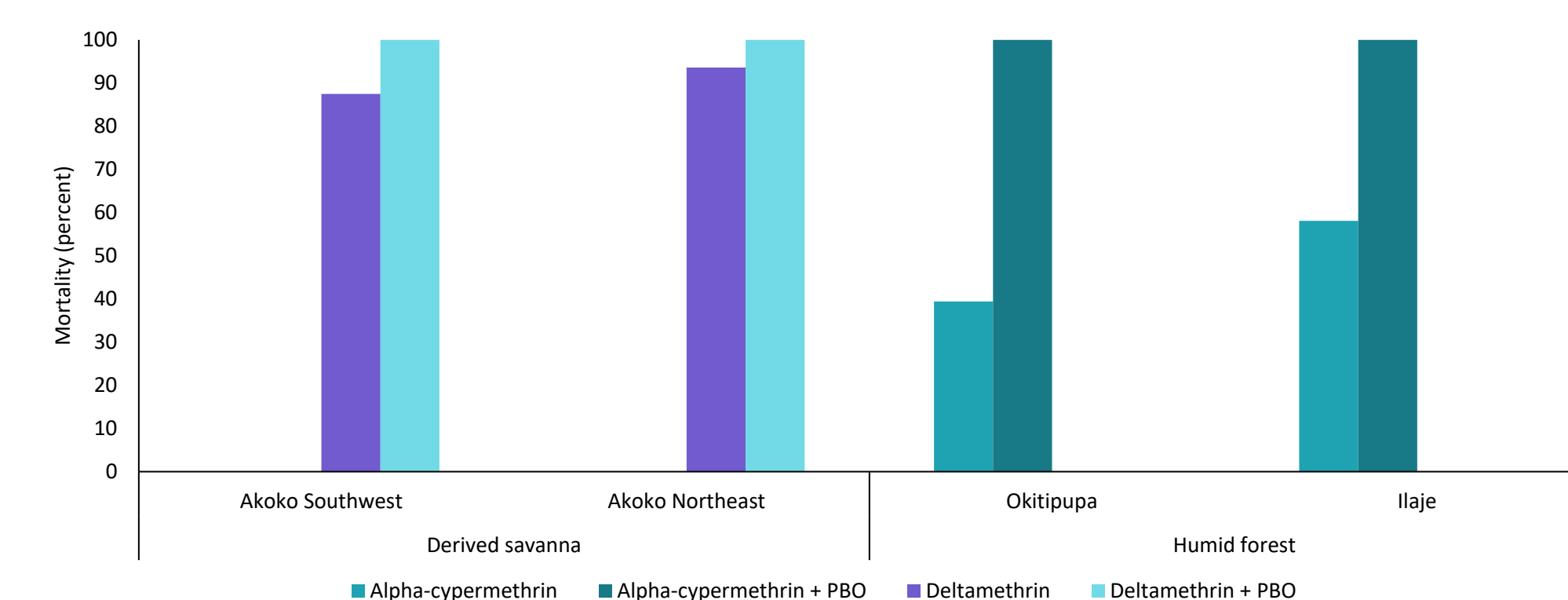
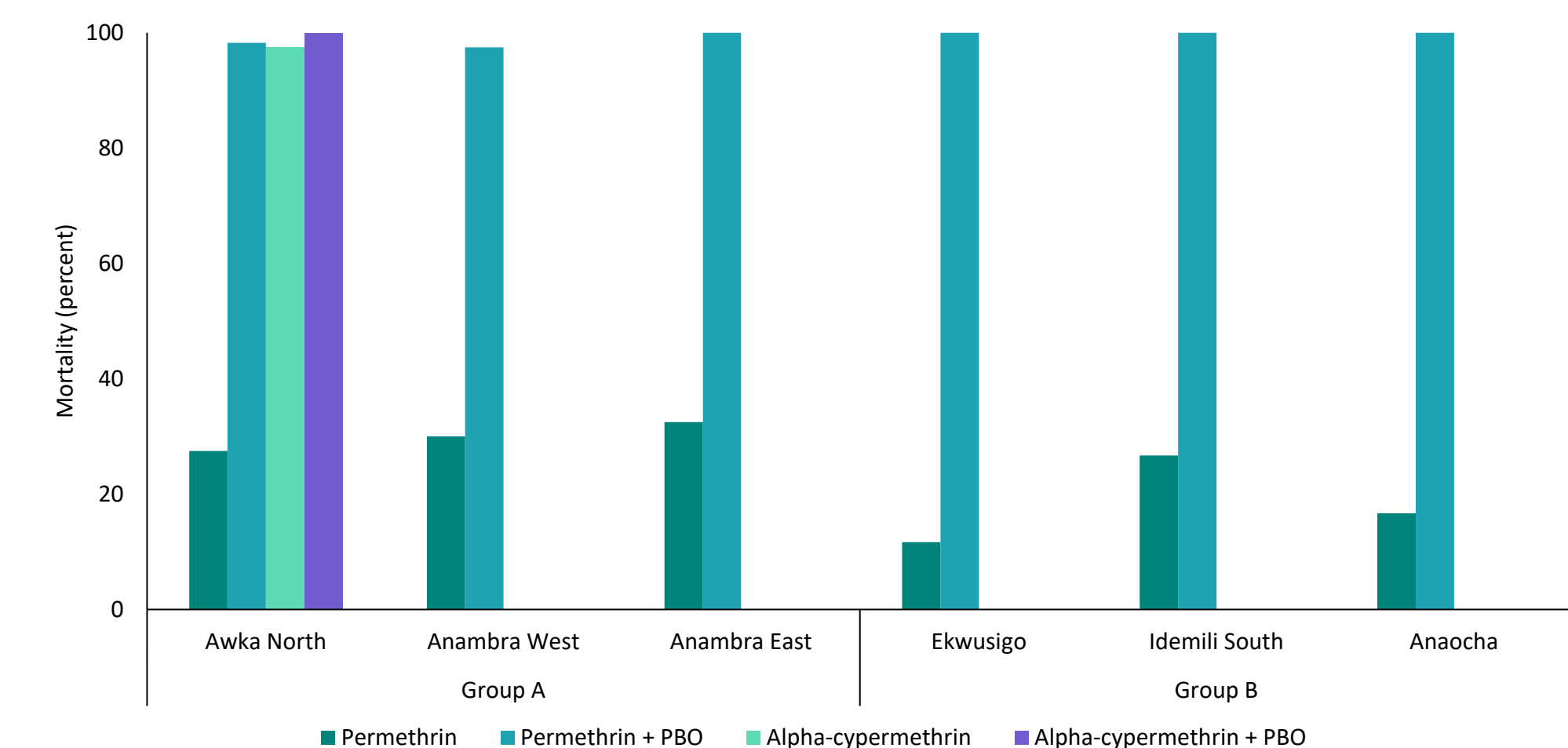


Figure 3. Baseline tests (pyrethroids + PBO) in Anambra state



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