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Estimating the potential impact of surveillance test-and-treat posts to reduce malaria in border regions in sub-Saharan Africa: A modelling study

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IDM Annual Symposium, 2 October 2024

Background

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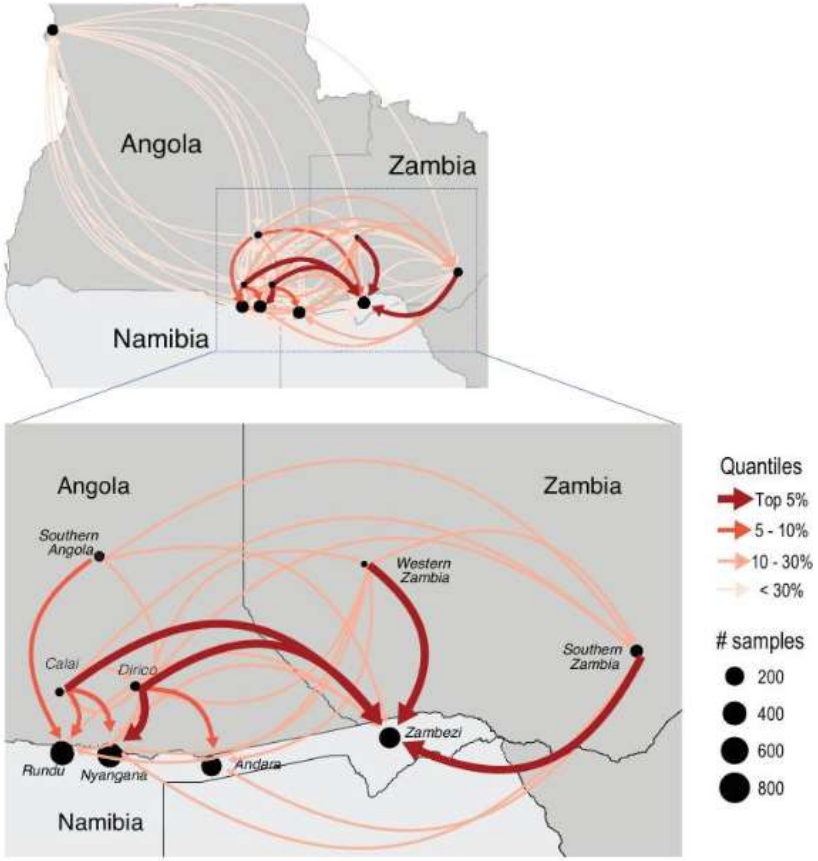
Zeroing in on Malaria Elimination: Final Report of the E-2020 Initiative. (2021)

Background



Year	Age group years	Travelled to mainland EG in previous 8 weeks	Prevalence of *P. falciparum* infection	Odds ratio (95% CI)
			% (N)	
2013	2-14	No	26.4 (5,579)	1
→		Yes	56.4 (252)	2.80 (2.14-3.67)
	>15	No	17.2 (6,322)	1
→		Yes	27.8 (586)	1.65 (1.35-2.01)
2014	2-14	No	17.7 (6,810)	1
→		Yes	41.7 (288)	3.33 (2.59-4.29)
	>15	No	11.7 (6,618)	1
→		Yes	19.0 (626)	1.70 (1.37-2.10)

Tessema S et al. eLife. 2019; 8:e43510

Bradley J et al. Malar J. 2015; 14:1-7

Background

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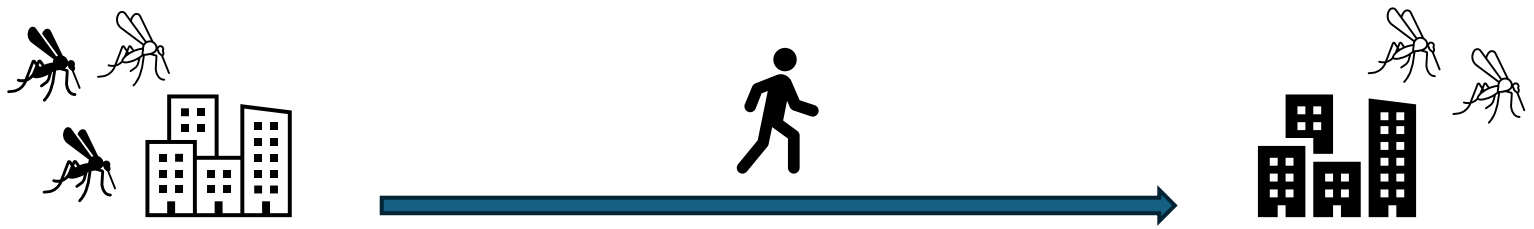
Two main strategies exist to limit the introduction of new infections from one country to another caused by human movement:

A) targeting the “source” population

B) intervening during migration or shortly after entry



Background

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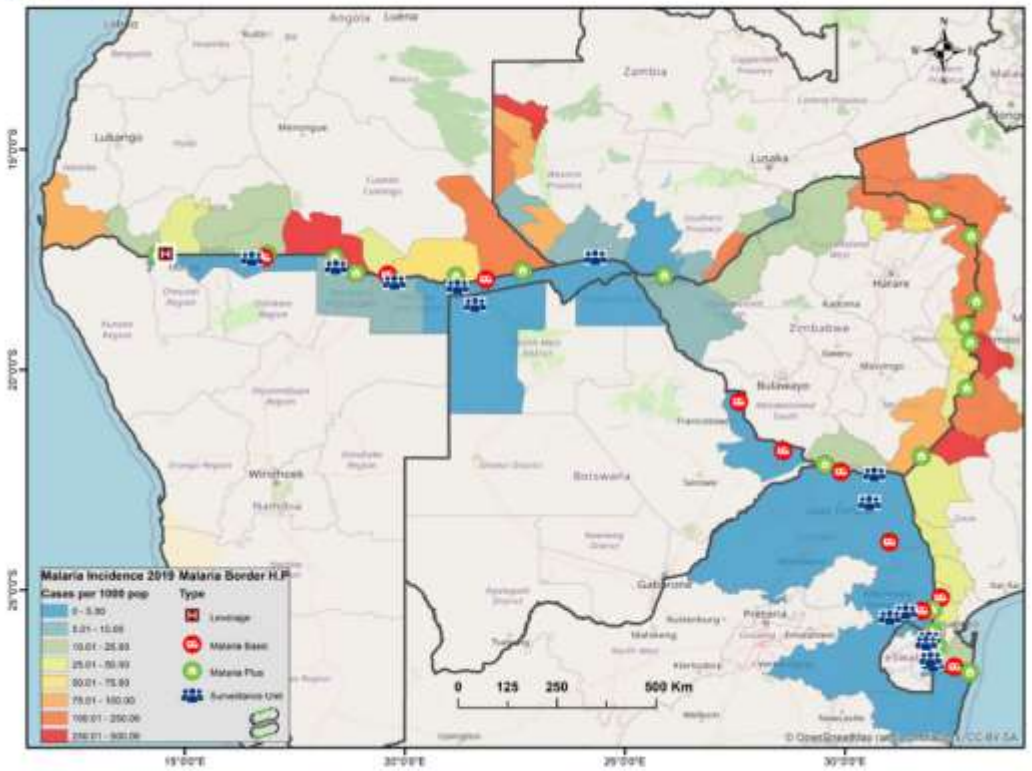
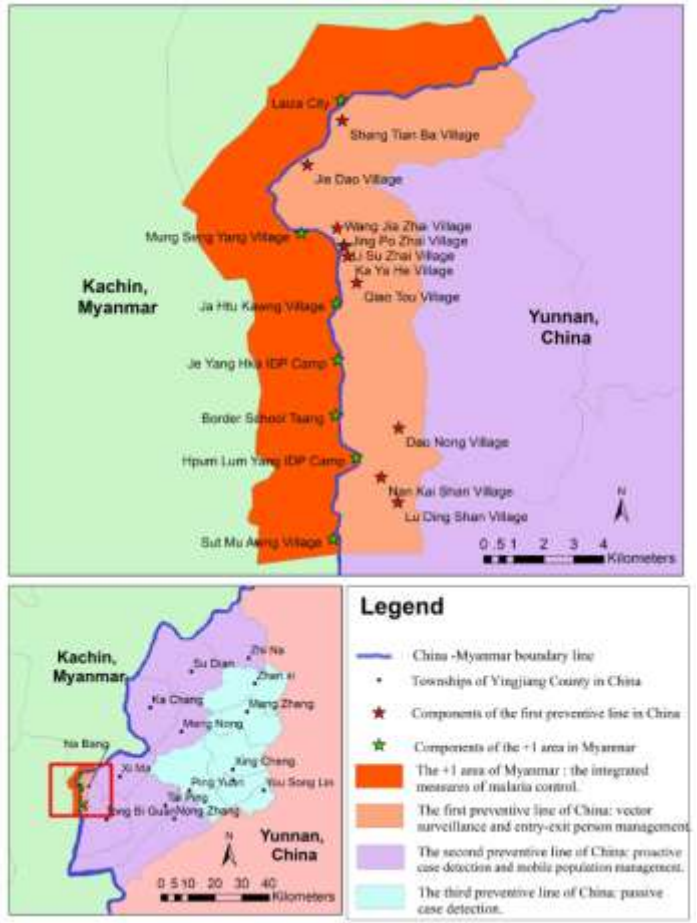
Figure 1. E8 Malaria border health posts and malaria case incidence in border districts during April to June 2019



Source: E8 Secretariat



Malaria Border Health Post Evaluation Study. Elimination 8, SADC. (2020)

Zu-rui L et al. BMC Infect Dis. 2021; 21:1-11

Objective

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Two main strategies exist to limit the introduction of new infections from one country to another caused by human movement:

A) targeting the “source” population

B) intervening during migration or shortly after entry

To estimate the effectiveness of border posts on total cases in malaria-endemic sub-Saharan Africa using an individual-based, mathematical metapopulation model of *P. falciparum*.

Methods

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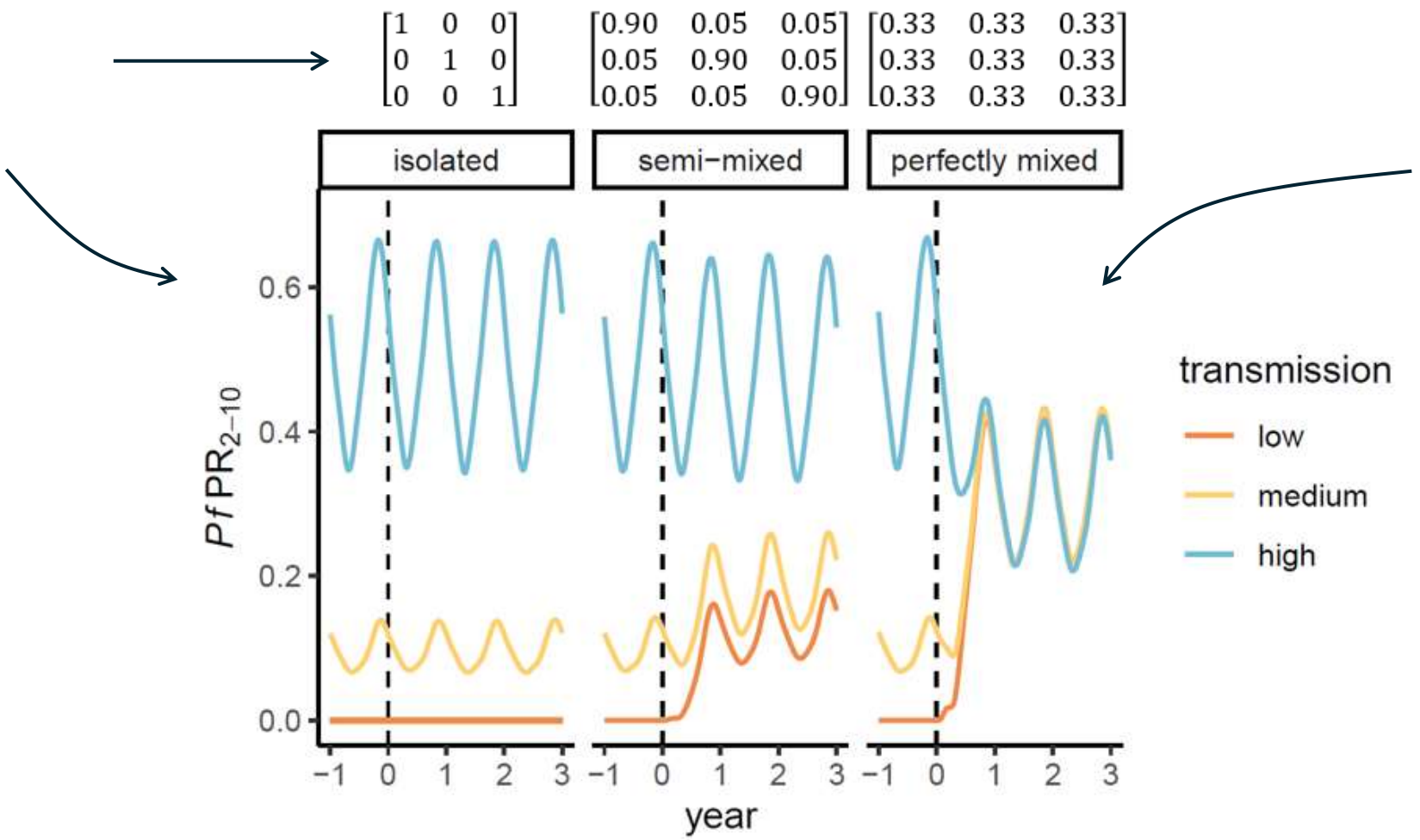

Methods

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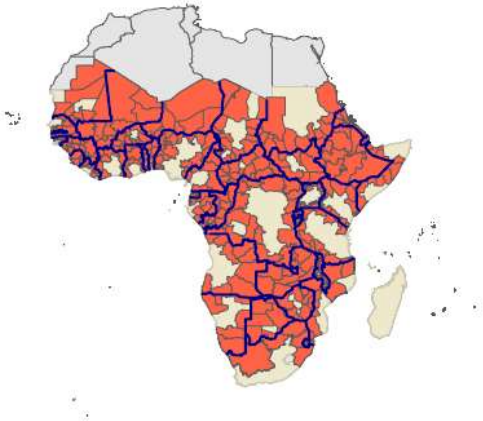
A



First sub-national administrative level units which touch an international border
44 countries represented

Methods

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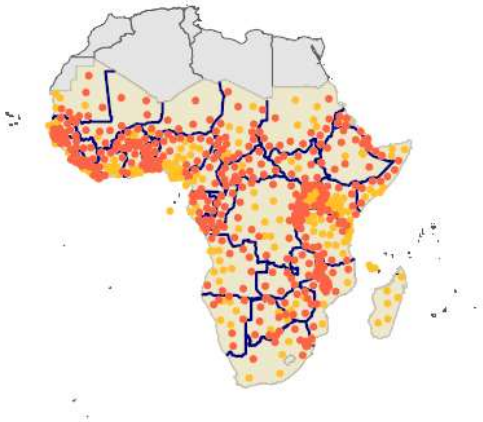
A

B



401 touch an international border (red)
235 interior (orange)

Methods

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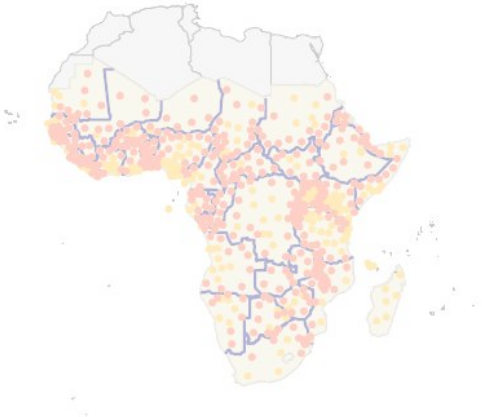
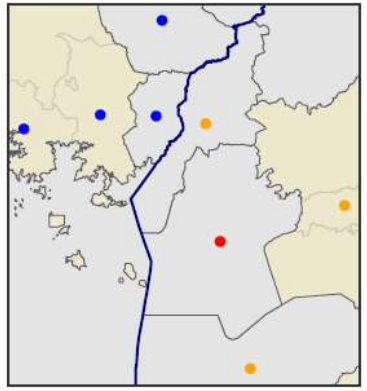
A

B



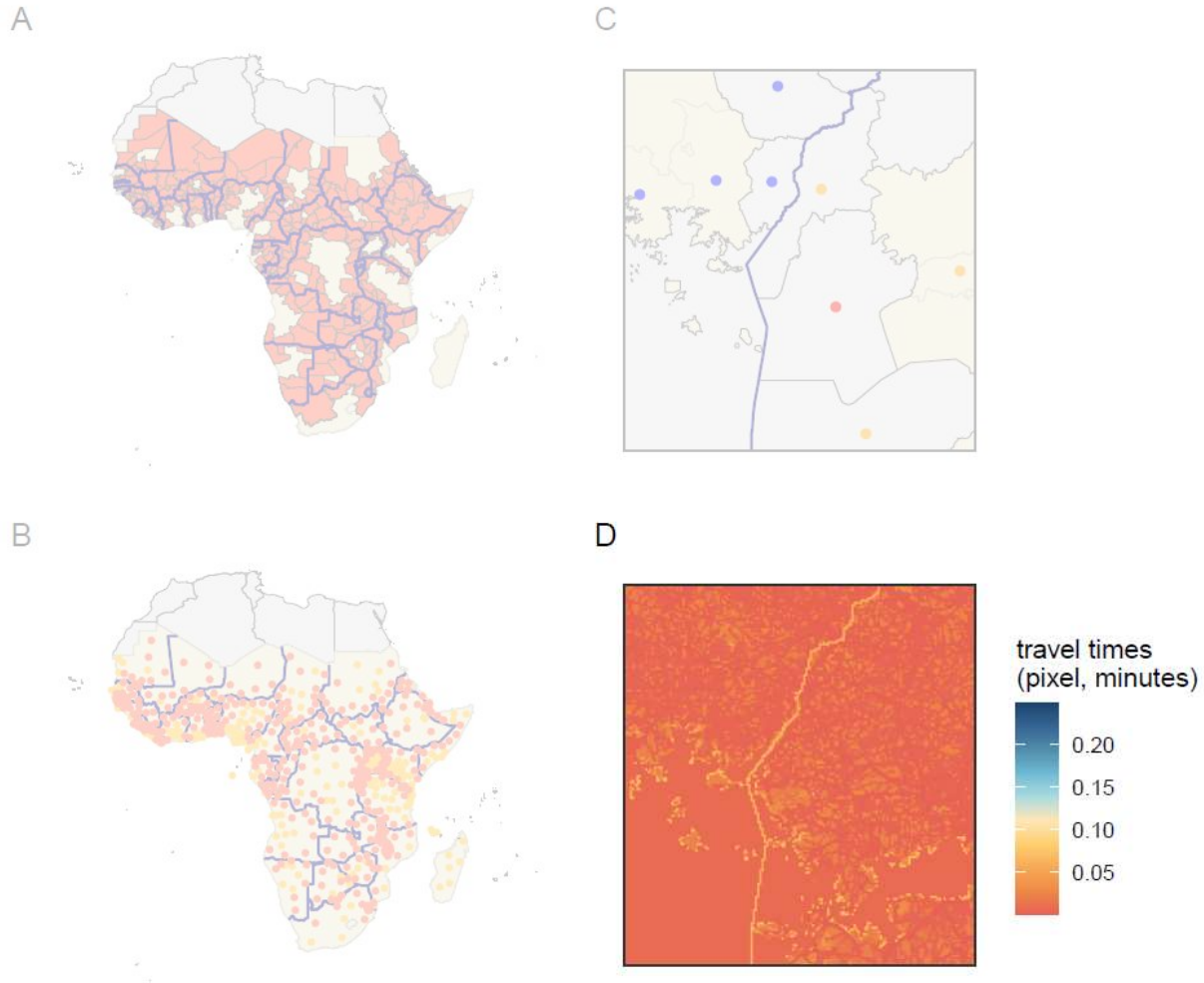
C



Example cluster

Seed point (red)
Three nearest national neighbors (orange)
Four nearest international neighbors (blue)

Methods



Land-based Travel Speed Friction Surface
Malaria Atlas Project 2015

Methods

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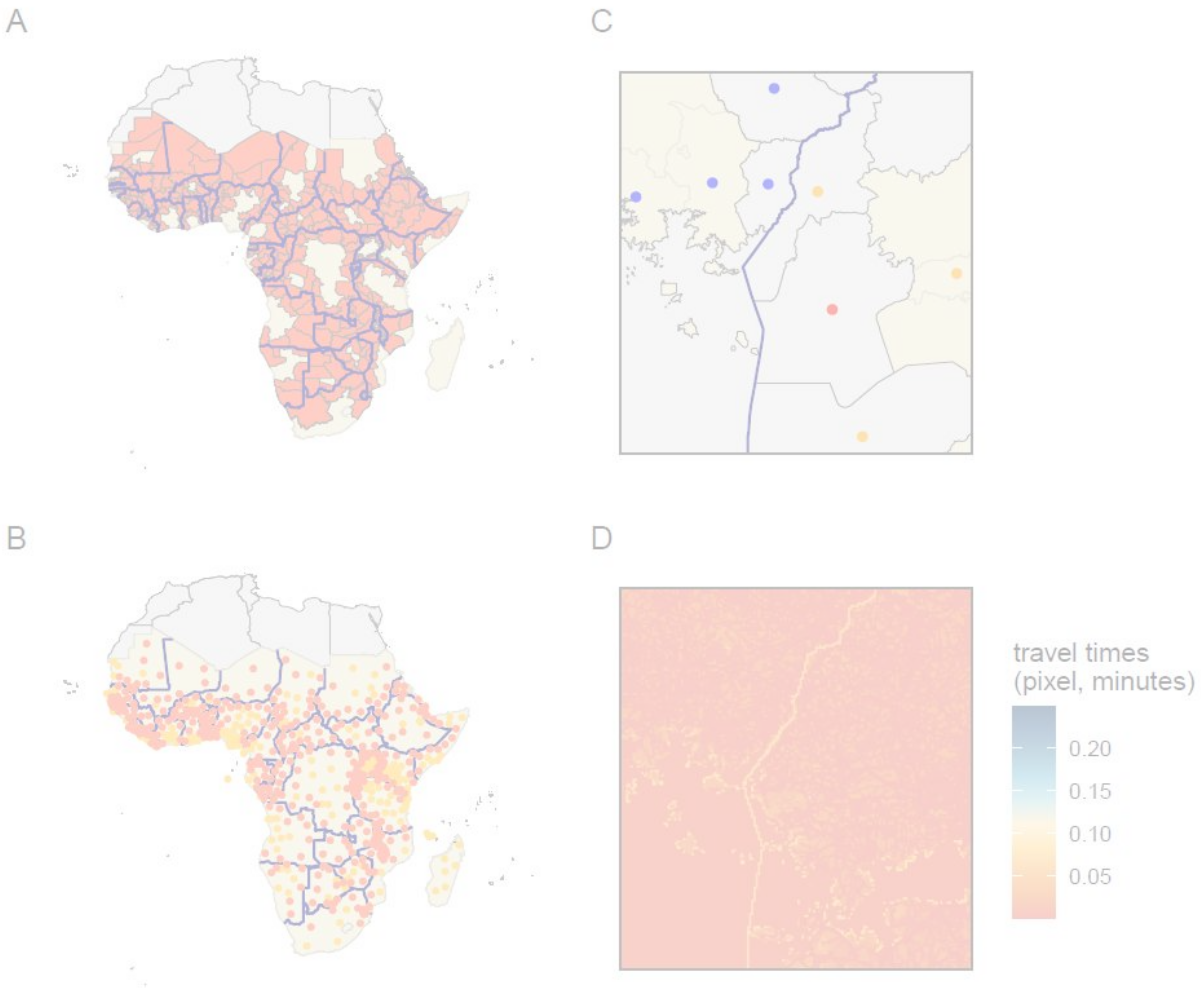
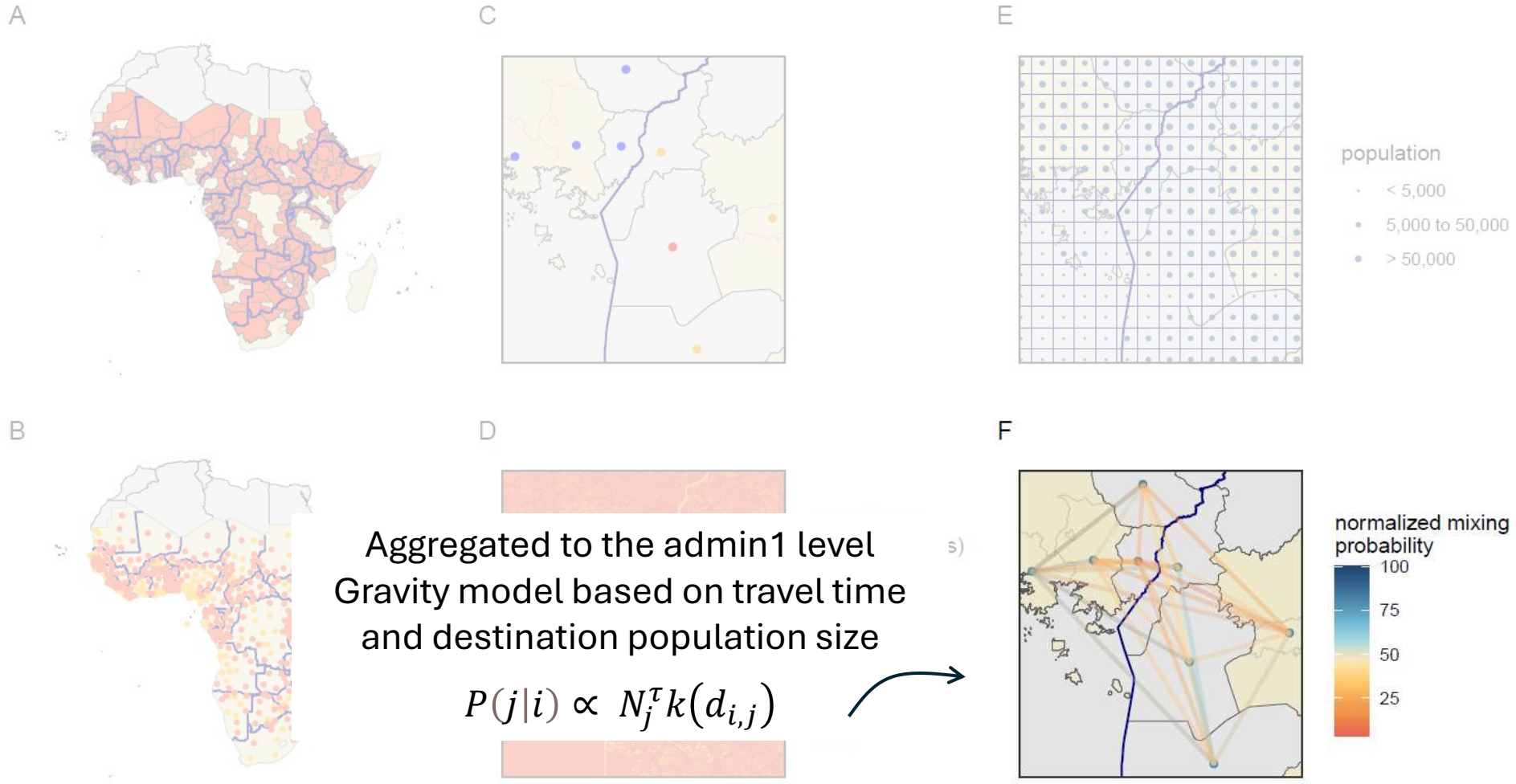


0.1x0.1 degree grid surface
WorldPop 2020

Methods



Aggregated to the admin1 level
Gravity model based on travel time and destination population size

$$P(j|i) \propto N_j^{\tau} k(d_{i,j})$$

Methods

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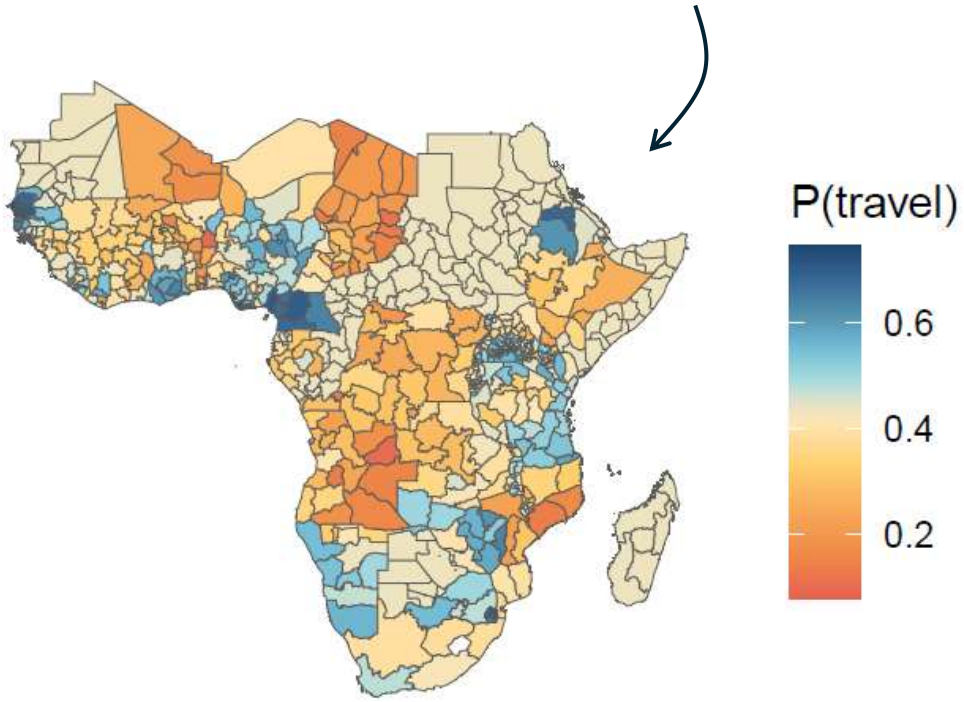
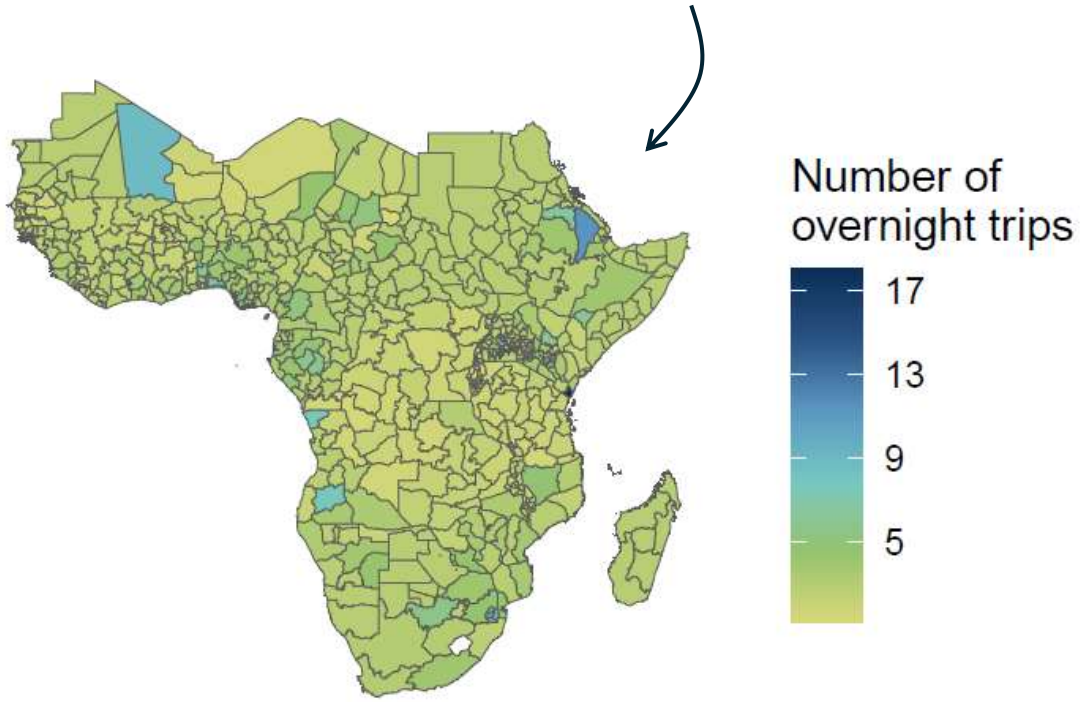
mean P(overnight travel): 0.43 (range: 0.08 to 0.75)

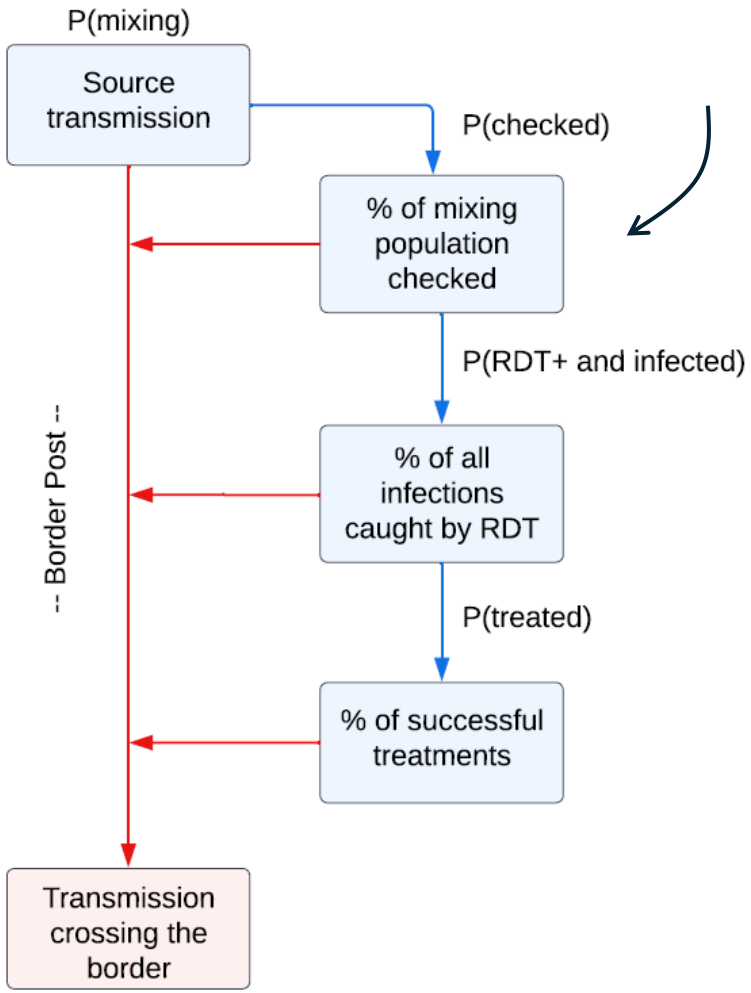


mean # overnight trips: 2.79 (range: 1.14 to 18)

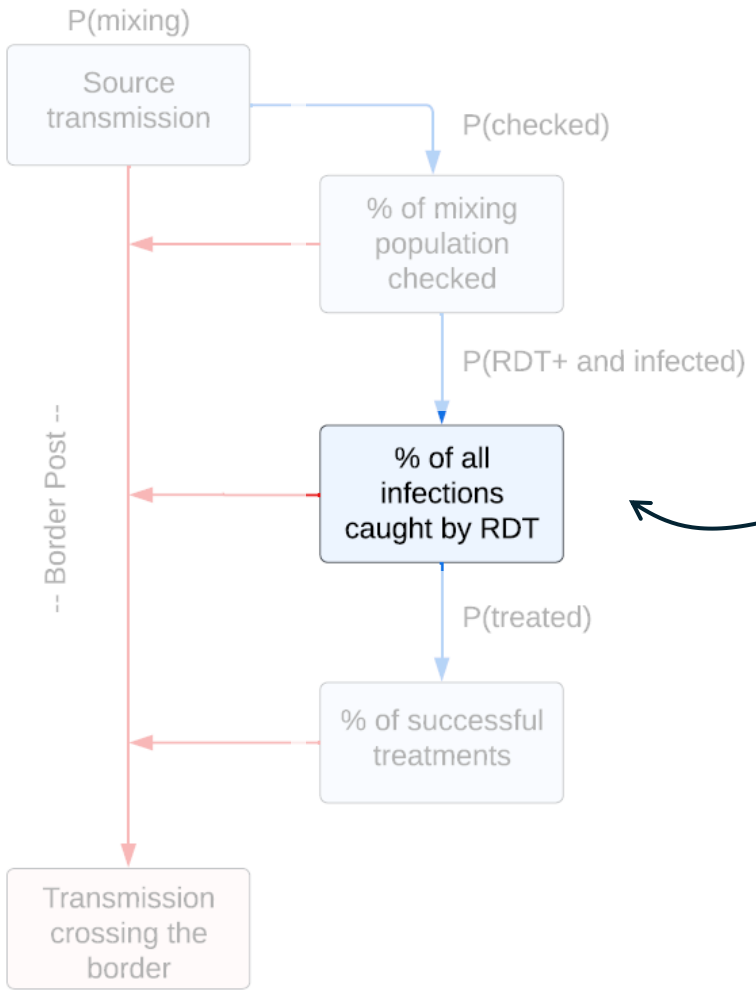


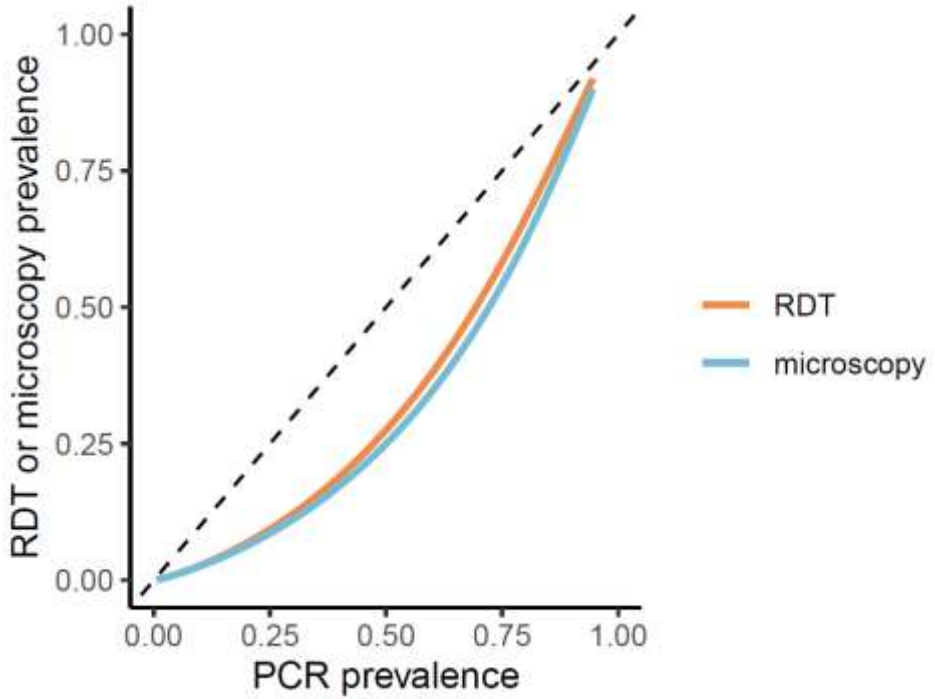
Data from the Demographic and Health Surveys Program
Data summarized for the last 12 months (admin1 mean of the cluster medians)

Methods


P(mixing)
Source transmission
P(checked)
% of mixing population checked
P(RDT+ and infected)
% of all infections caught by RDT
P(treated)
% of successful treatments
-- Border Post --
Transmission crossing the border

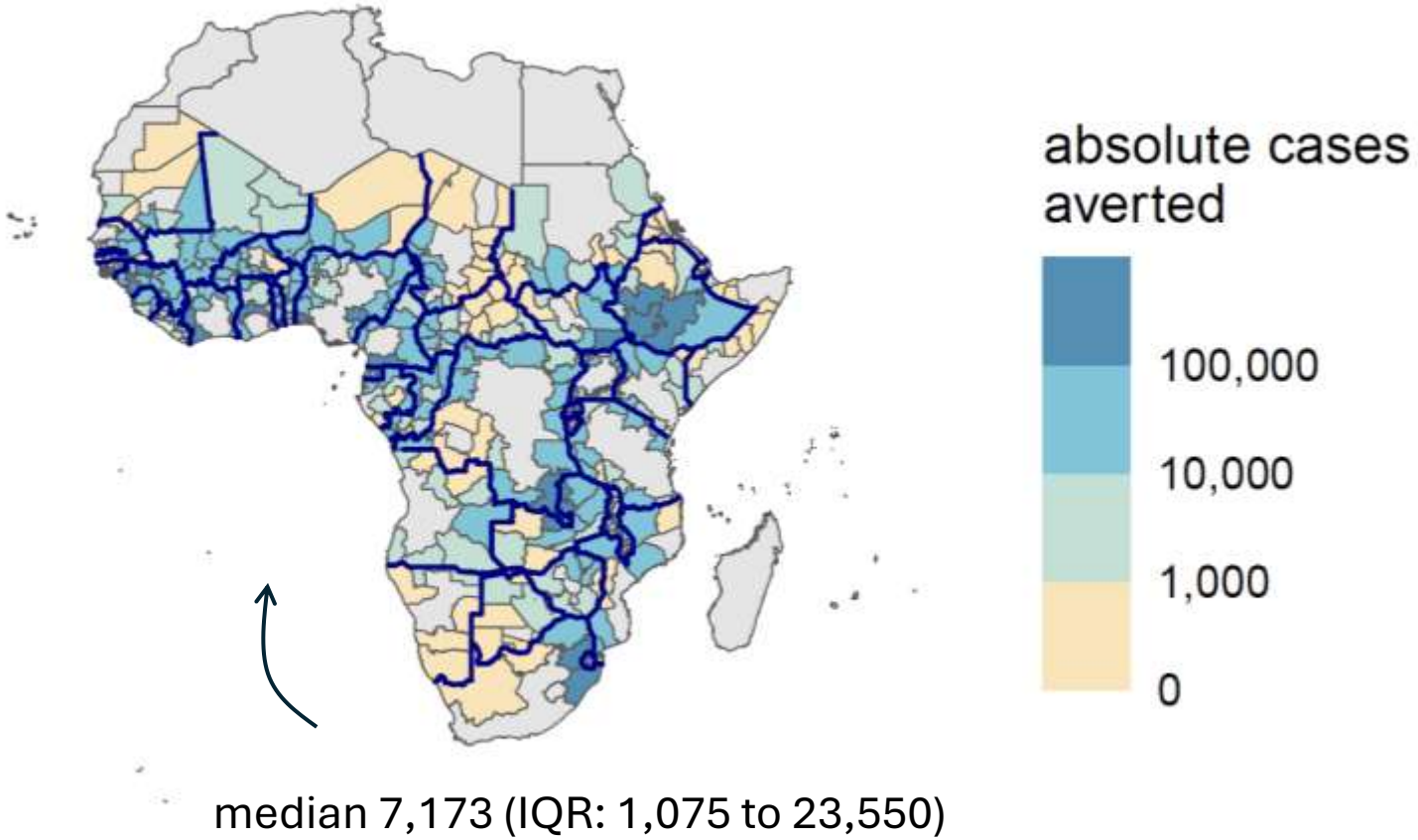
Methods





Data from: Wu L. et al. Nature. 2015; 528:S86-S93
Okell L et al. Nat Commun. 2012; 3:1237.

Results



median 7,173 (IQR: 1,075 to 23,550)
over 10 years

Results

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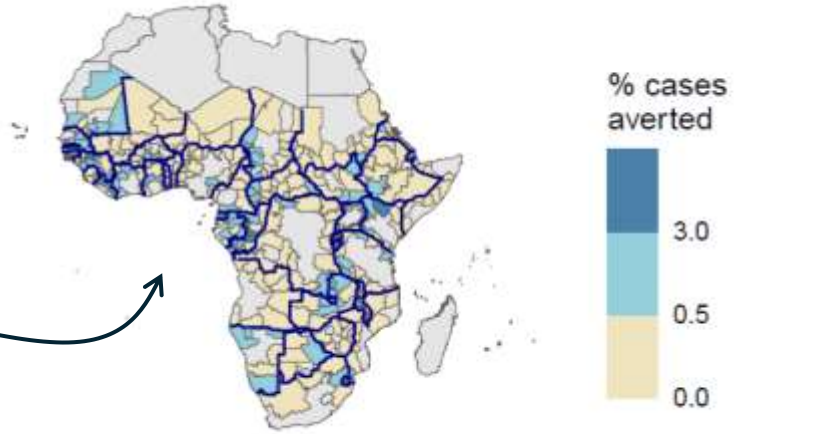
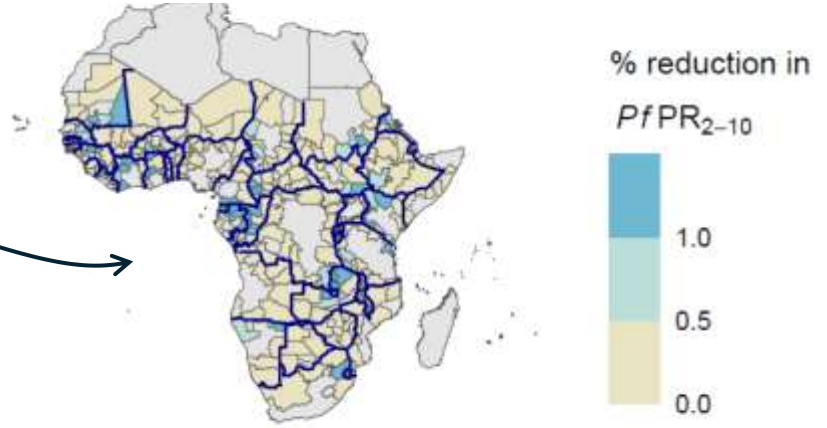
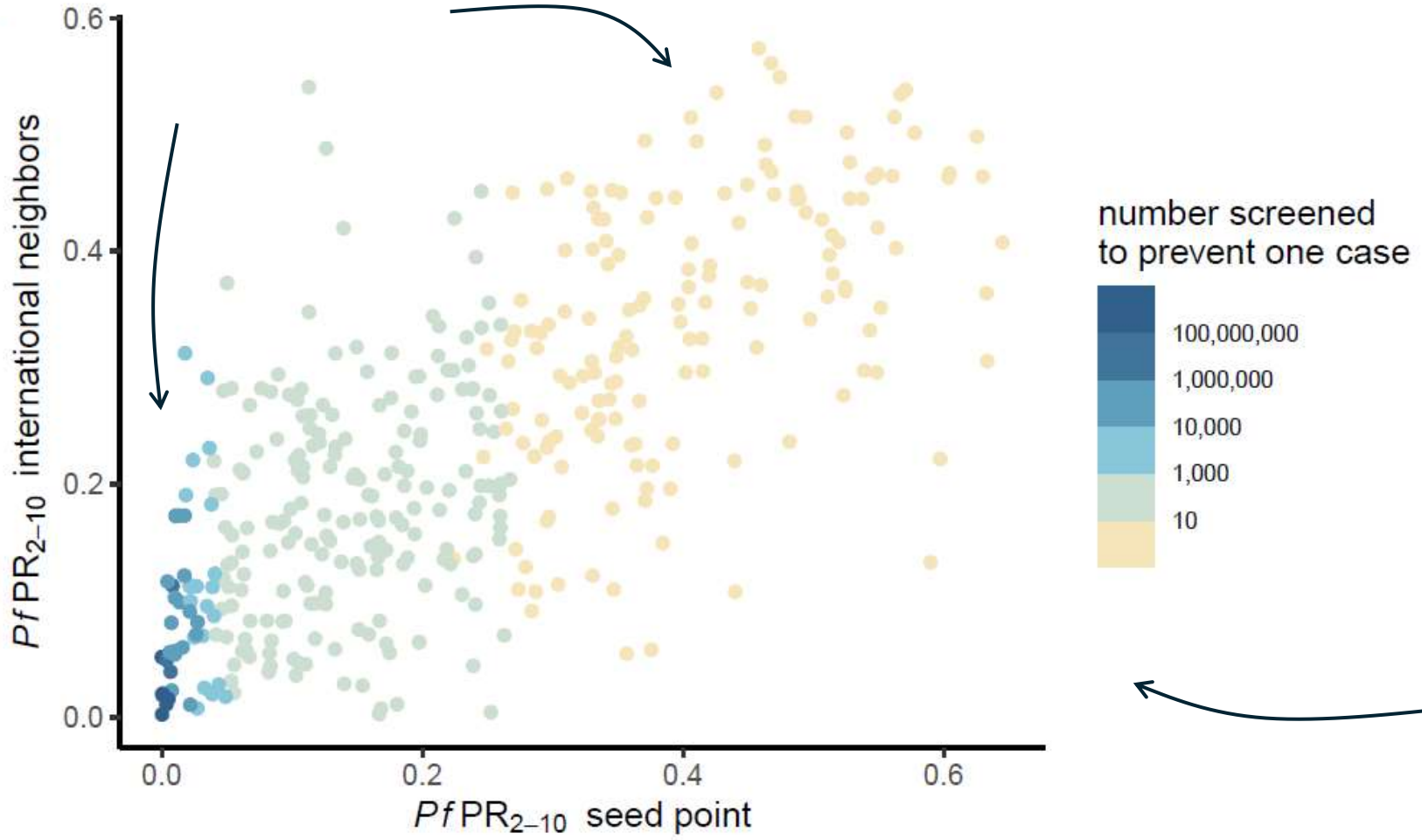
median 0.28% (IQR: 0.07 to 0.61)
over 10 years



median 0.21% (IQR: 0.04 to 0.44)
over 10 years



Results



A median of 14 (IQR: 5 to 82) people would need to be screened at a border post to prevent one case

Results

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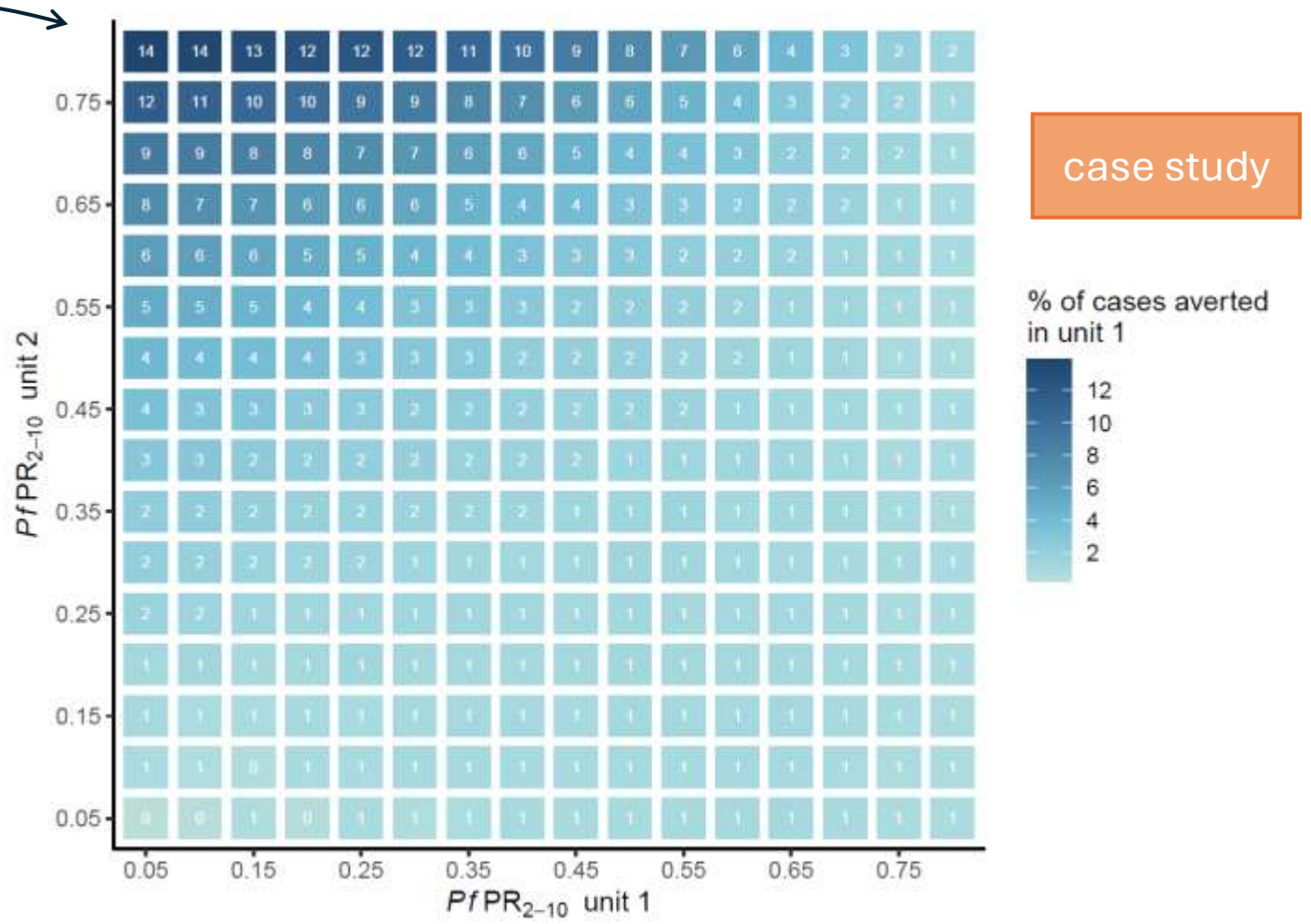
Border posts reduced the highest percentage of cases in scenarios where a high transmission unit bordered a low-transmission unit



case study

Results

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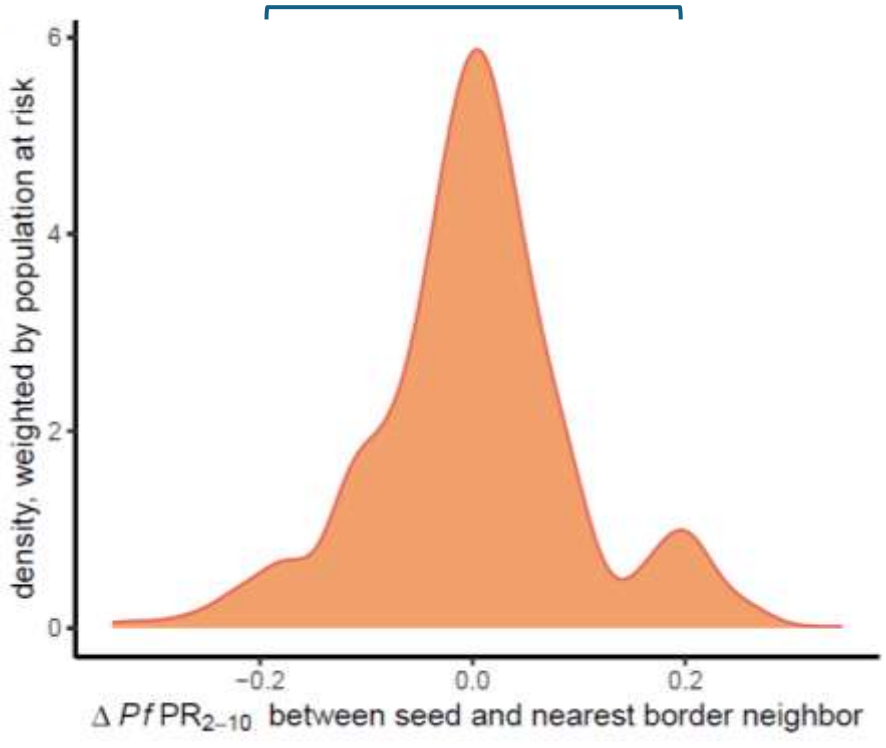
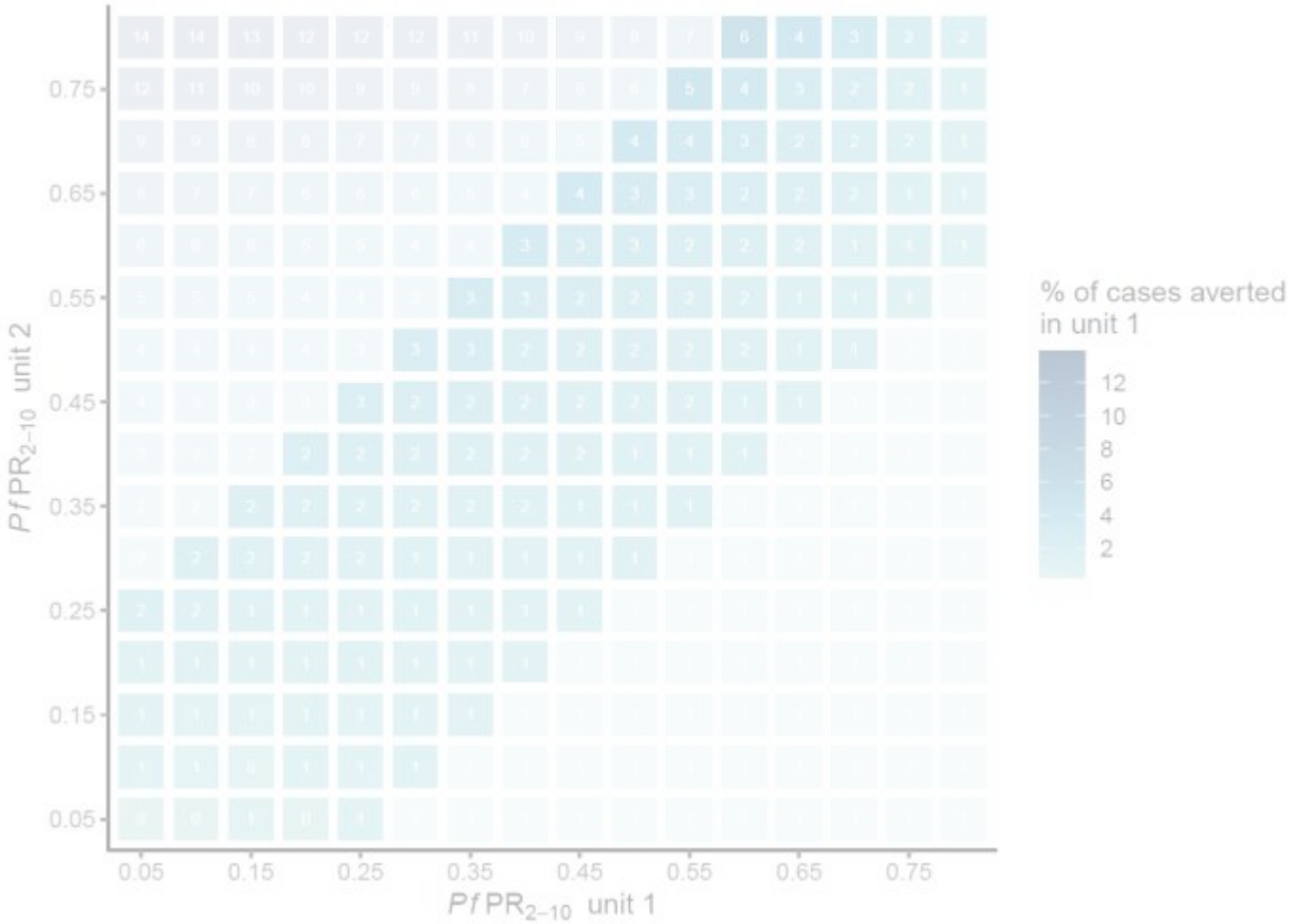
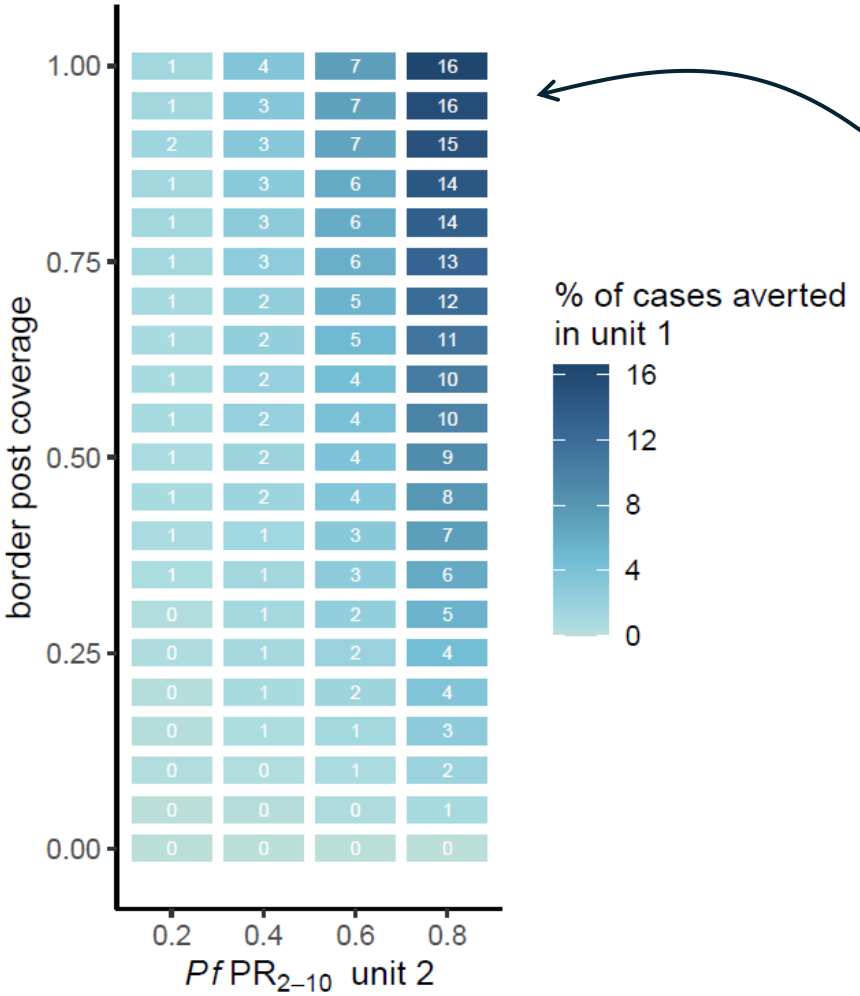
border neighbors tend to have small transmission differences





Results



case study

Border posts reduced the highest percentage of cases in scenarios where a high transmission unit bordered a low-transmission unit with high intervention coverage

Conclusions

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- Border post interventions averted cases and reduced *Pf*PR_{2-10} in border areas, particularly among low-high pairings
- The difference in *Pf*PR_{2-10} values on either side of a border has a large effect on the cases averted by the intervention
- Border posts will not allow a country to reach elimination in isolation
  - Only a small proportion of individuals are mixing at each time unit
  - RDTs are not as sensitive in low transmission areas

Conclusions

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Limitations

- Lack of data on implementation costs
- Lack of data on feasibility (mixed findings in the literature)
- Results cannot be interpreted as recommendations for specific settings
- Wide variability in admin1 unit land areas

Future work

- Assess border posts vs. resource sharing and synchronizing vector control campaigns
- Integration alongside other interventions (monitoring artemisinin resistance, HIV / TB / COVID-19 / dengue screening)

Acknowledgements

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