Prevalence and Determinants of Malaria among Children in Zambézia Province, Mozambique

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BACKGROUND

- Malaria is the leading cause of death among children in Mozambique.[1]
- Prevalence and factors associated with malaria are not well studied among children in rural Zambézia Province.
- Whether malaria prevalence varies across diverse districts within the province is unknown.
  - Differences in bioclimatic determinants of mosquito suitability – elevation, temperature, and precipitation.[2]
  - Differential distribution of insecticide treated bed nets (ITN).[3]
  - Differential coverage of indoor residual spraying (IRS) campaigns.[4]
- Aims:
  1. Describe the prevalence of malaria among children 6-59 months.
  2. Determine whether prevalence of malaria among children varies between 3 diverse districts within the province.
  3. Identify factors associated with malaria among children.

METHODS

Study Design: Cross-sectional, province-wide survey of female heads of household in April and May 2014.

Sampling Frame and Methodology:
- The province is divided into 17 districts, which are sub-divided into ~9000 enumeration areas (EA).
  1. Sampling frame was stratified by district, and design weight constructed to compensate for oversampling in 3 focus districts.
  2. EA selected for within stratum using probability proportional to size.
  3. Households within each EA were randomly selected.
  4. Within households, 2 children 6-59 months were randomly selected.

Sample Summary/Population: 2540 children within 262 EA.
- 201 EA in the oversampled focus districts.
- 61 EA from the remaining 14 districts.

Measurements:
- *Outcome*: "symptomatic malaria", defined as caregiver report of child with fever confirmed to be malaria by diagnostic test in past 30 days.
- *Covariates (selected)*: district, age, sex, weight, caregiver education, rural/urban setting, income, roofing material, electricity in home, pig raising, distance from health facility, and ITN use.
- *Mosquito suitability:* GIS approach was used to create a map based on bioclimatic variables[5] – elevation, temperature, and precipitation.
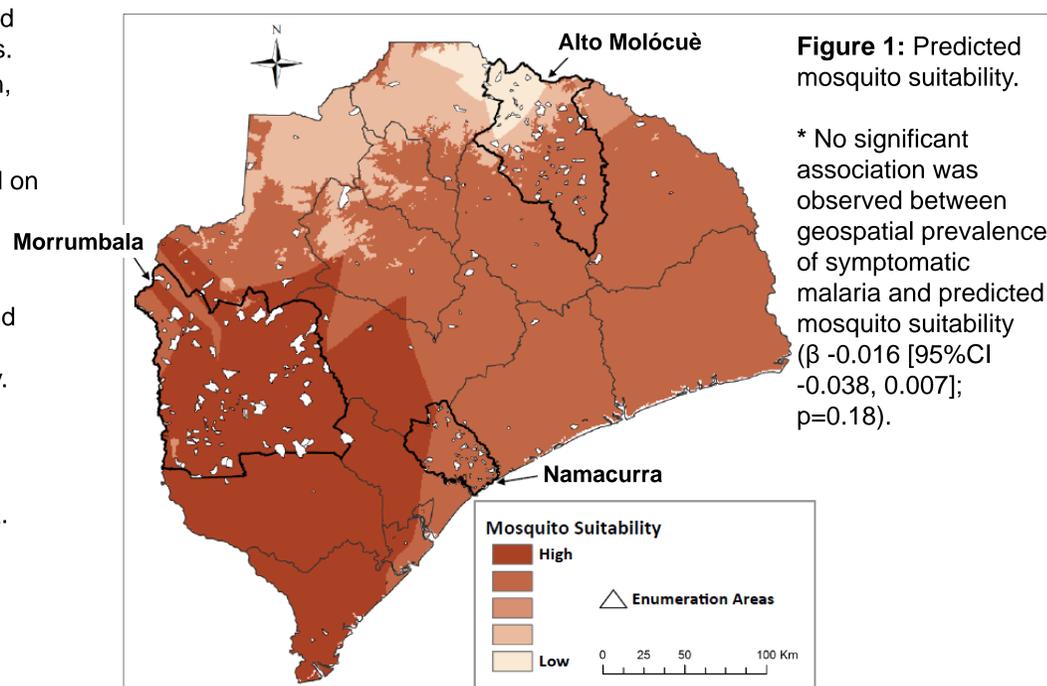
Statistical Analyses:
- Continuous variables reported as weighted estimates of median, and categorical variables reported as weighted percentages, with observations weighted by inverse of household sampling probability.
- Prevalence of symptomatic malaria calculated as the proportion of children with fever and a positive malaria diagnostic test.
- Comparisons between focus districts made using chi-square tests.
- Multivariable logistic regression to identify associations with malaria.
  - Robust covariance for staged sample design and clustering.
  - Non-linear continuous variables modeled using restricted cubic splines.
  - Multiple imputation to account for missingness.
- Ordinary least squares regression compared prevalence of malaria within EA to predicted mosquito suitability.

RESULTS

Table 1: Attributes and behaviors of children, female head of household respondents, and households in Zambézia Province, Mozambique.

	All Province (n=2540)	Alto Molócuè (n=781)	Morrumbala (n=522)	Namacurra (n=416)	P-value
Children					
Female	49.8%	52.5%	56.7%	50.8%	
Age (months)	24 (12-36)	24 (12-36)	24 (12-36)	24 (12-36)	
Weight (kg)	11 (9-13)	10 (9-12)	10 (9-13)	11 (10-13)	
Slept under bed net	59.6%	65.7%	48.5%	88.4%	<0.001
Fever in Past 30 days	43.4%	46.4%	38.4%	49.4%	<0.001
Missing	39 (2%)	24 (3%)	4 (1%)	1 (<1%)	
Went to Health Facility (if fever)	91.3%	87.1%	86%	93.1%	<0.001
Missing	269 (25%)	75 (21%)	49 (23%)	56 (28%)	
Malaria Test Performed (if HF)	66.6%	75.8%	71.4%	65.6%	0.003
Missing	19 (3%)	14 (6%)	0	0	
Positive Test (if test)	67.3%	66.4%	69.6%	80.4%	0.18
Missing	4 (1%)	1 (1%)	0	0	
Malaria Prevalence	**12.8%**	**15.9%**	**13.6%**	**16.8%**	**<0.001**
Female Heads of Household					
Age (years)	26 (22-33)	26 (22-33)	28 (22-38)	27 (21-33)	
Education (years)	3 (0-5)	4 (2-6)	1 (0-2)	2 (0-5)	
Slept under bed net	55.3%	60.1%	38.3%	87.2%	<0.001
Household					
Rural	77.5%	89.7%	96%	100%	
Household Size	5 (4-6)	5 (4-6)	5 (4-6)	5 (4-5)	
Children <5 years	2 (1-2)	2 (1-2)	2 (1-2)	2 (1-2)	
Income ≥ $1USD/day	17.4%	36.6%	24.5%	7.1%	
Thatch Roof	78.7%	84.8%	93.3%	83.2%	
Electricity	11.4%	7.5%	4%	0.7%	
Pig raising	9.2%	28.4%	32.7%	1.1%	
Distance to HF (km)	9 (4-17)	12 (6-18)	11 (6-21)	6 (4-8)	
No Bed Nets	33.8%	20.1%	53.1%	7.3%	<0.001

Figure 1: Predicted mosquito suitability.

* No significant association was observed between geospatial prevalence of symptomatic malaria and predicted mosquito suitability (β -0.016 [95%CI -0.038, 0.007]; p=0.18).

Alto Molócuè

Morrumbala

Namacurra

Mosquito Suitability
High
Enumeration Areas
Low
0 25 50 100 Km

Table 2: Multivariable logistic regression of malaria diagnosis among 2501 children 6-59 months of age in Zambézia Province, Mozambique.

	Odds Ratio (95% CI)
District: Alto Molócuè (ref)	1
Morrumbala	1.24 (0.76-2.02)
Namacurra	1.40 (0.88-2.24)
Other	0.86 (0.55-1.34)
Age (per 6 months)	1.04 (0.95-1.14)
Sex (male vs. female)	0.96 (0.75-1.24)
Weight (per 1 kg)	0.87 (0.60-1.26)
Slept under bed net the night prior to survey	1.28 (0.86-1.92)
Respondent Education (5 vs. 0 years)	**1.88 (1.31-2.70)**
Children <5 years in home (per 1 less child)	**1.25 (1.01-1.56)**
Income ≥1000 MZN/month (~$1 USD/day)	**1.56 (1.11-2.22)**

Excludes 39 without known fever outcome. 380 had a malaria diagnosis. The model also adjusts for: respondent age, understanding of Portuguese, rural/urban setting, household size, roofing material, electricity in home, pig raising, distance to health facility, and whether she slept under bed net the night prior to survey.
* There were no significant associations in a sensitivity analysis restricted to children who accessed malaria diagnostic testing (n=533).

CONCLUSIONS

- **Malaria is highly prevalent among children in Zambézia Province, Mozambique.**
- **In unadjusted comparisons, prevalence of symptomatic malaria varies significantly between diverse districts.**
  - **Despite high mosquito suitability and low ITN use, Morrumbala had the lowest observed malaria prevalence. Perhaps, due to unmeasured covariates (e.g. IRS) and confounding by low access to health services.**
- **In adjusted comparisons, factors potentially facilitating access to health services – higher levels of female caregiver education, higher household income, and having fewer young children in the household – were associated with malaria.**
- **These findings should inform resource allocation in the fight against malaria in Mozambique.**

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