

Malaria Indicator Surveys Demonstrate a Markedly Lower Prevalence of Malaria in Large Cities of Sub-Saharan Africa

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Background

- One in 8 Sub-Saharan Africans (SSA) lives in a large city (pop. over 750,000). In 1950, there were no large cities in SSA. Now there are 51, with a combined population of 100 million. [1]
- Striking drop-offs in malaria transmission from rural to urban areas have been well documented [2-6]. Yet public health and clinical decisions often take a “one-size -fits-all” approach, informed by routine health system data. Such data may be based largely on empiric diagnosis and suggest that malaria is highly endemic in both urban and rural areas. In Ghana, for example, roughly 40% of facility outpatient visits have been attributed to “malaria” across the country [7].
- Decision makers prefer evidence from their own country, and Malaria Indicator Surveys (MIS) help meet this need. The last 5 years have seen an extraordinary investment in these large, nationally representative national surveys measuring microscopic parasitemia and other malaria indicators in children, typically 6-59 months of age. An MIS is often imbedded in a broader DHS, MICS or AIDS national survey. [8]
- The 2013 *Ghana Urban Malaria Study* [7] used MIS and other local data to provide decision makers with a compelling assessment of the relative burden of malaria in large cities versus rural areas. Building on that positive experience, the current study analyzed existing MIS data in 22 large cities in 15 countries across Sub-Saharan Africa.

Methods

Data sources:

Thirteen nationally representative surveys which included malaria microscopy were obtained from the Measure DHS archive, and 3 from national authorities (Kenya 2010 MIS, Zambia 2010 MIS, and Ghana 2011 MICS) [8]. Surveys from an additional 12 countries were not yet available. Most data had been collected in the late rainy season, as recommended. Data was suppressed for cities where fewer than 50 children had been sampled.

Geo-spatial analysis:

Geo-coordinates for each survey cluster were used to determine the distance from each cluster to the center of the large cities (pop. >750,000). “Rural” vs. “urban” classifications for each cluster were retained from the individual survey. For urban clusters within 25 km of the center of a large city, Google Earth® satellite imagery was used to determine whether they fell within the city or should be classified as “other urban,” according to pre-set criteria. Data from all sites within city boundaries were pooled and compared to rural sites within 150 km of the city center. Typically, rural clusters in an MIS are those with <5000 population. A detailed description of methods is available [9].

Results

- In 19 of 20 large cities, from 0 to 7.4% of children were found to be parasitemic. The one outlier was Ouagadougou (17.9%). **Table 1.**
- The prevalence in 20 large cities was 0 to 40% of that in outlying rural communities (within 150 km). Findings typical for each of the large cities are illustrated in **Figure 1**, which maps the results obtained for Bamako from the Mali 2010 Special DHS.
- The difference in the prevalence between large cities and surrounding rural communities was statistically significant for all large cities except for Antananarivo, Kigali and Mombasa -- each with a very low prevalence in the comparison rural communities.
- In 14 of 20 large cities, all children in 75% or more of survey clusters were malaria parasite-free.
- The positive predictive value of reported “fever” within the past 14 days was consistently lower in urban areas. **Figure 2.**
- The testing rates for fever ranged from 7.8% in rural Burkina Faso to 65.7% in Kigali. (Where rate = #reported tested/#reported treated for fever at a health facility within the past 14 days). Rates were higher in rural areas than urban areas in 3 out of 14 countries.

Figure 1.
Geo-spatial Analysis of Clusters from Malaria Indicator Surveys (MIS): Example of Bamako, Mali

Key:
 = proportion infected in a rural cluster
 = proportion uninfected in a rural cluster
 = proportion infected in an urban cluster
 = proportion uninfected in an urban cluster
 Area of each pie chart is proportional to the number of children examined in that cluster (range: 10-24).

Sources: Mali 2010 Special DHS; Google Earth®

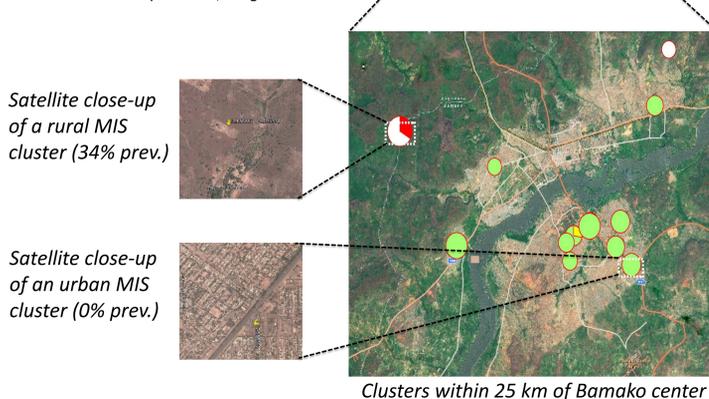
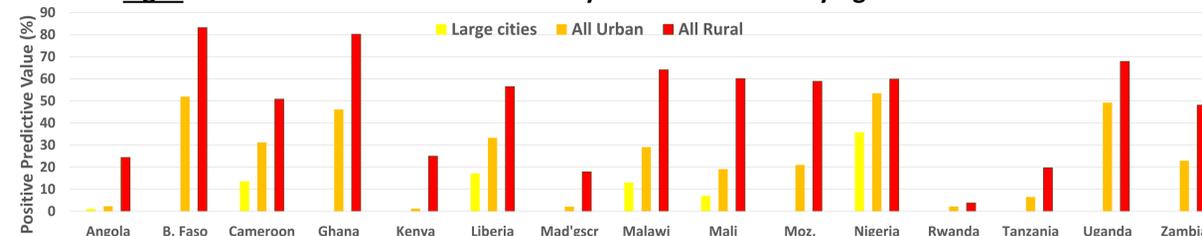


Table 1.
Prevalence of Malaria Parasitemia in Children 6-59 mo in Large Cities and Rural Comparison[§] Communities

City	Pop (m)	Malaria Prevalence (%)				Rel. Risk (City/Rural)
		City		Outlying Rural		
		Prev.(%)	CI 95%	Prev.(%)	CI 95%	CI 95%
Nairobi, KEN	3.2m	0	0	4	0.8-7.3	0.0
Antananarivo, MDG	1.9m	0	0	0	0	-
Lusaka, ZAM	1.7m	0	0	10.8	5.7-16.0	-
Dar es Salaam, TNZ	3.4m	0.3	0-1.0	3.9	0.7-7.1	0.09
Dakar, SEN	2.9m	0.4	0-1.3	4.5	0.8-8.3	0.10
Kigali, RW	1.0m	0.5	0-1.4	2.8	1.6-4.0	0.18
Mombasa, KEN	0.9m	0.6	0-2.0	4.7	1.2-8.2	0.12
Luanda, ANG	4.8m	1.4	0.1-2.5	21.4	1.1-41.7	0.07
Lagos, NIG	10.8m	1.5	0-4.2	50	25.6-74.4	0.03
Maputo, MOZ	1.1m	2.2	0.1-4.1	12.3	5.7-18.9	0.18
Bamako, MAL	1.9m	2.4	0-7.3	53.3	39.6-67.1	0.05
Accra, GHA	2.5m	3.3	0.5-6.1	24.3	16.2-32.3	0.14
Blantyre, MLW	0.7m	4.6	1.5-7.8	39.7	20.2-59.1	0.12
Matola, MOZ	0.8m	4.9	1.4-8.4	12.3	5.6-19.0	0.40
Kampala, UG	1.6m	4.9	1-8.8	50	40.9-59.1	0.10
Kumasi, GHA	1.9m	5.3	1.1-9.4	34.7	29.5-40.0	0.15
Lilongwe, MLW	0.7m	5.5	1.8-9.2	45.9	37.1-54.8	0.12
Kano, NIG	3.3m	5.9	0-13.7	48.8	35.7-62.0	0.12
Monrovia, LIB	1.0m	7.5	3.2-11.8	31.5	27.2-35.8	0.24
Ouagadoug., BFA	1.9m	17.9	7.5-28.3	70.9	67.8-74.1	0.25

[§]Rural communities within 150 km of city center by the haversine formula. For cities at >1000m, rural sites were also within 200m of the city's altitude. For Kenya and Ghana (no GPS data available), comparison clusters came from the same district or ecologic zone.

Fig 2. Positive Predictive Value of History of Fever for Identifying Recent Malaria Infection^{1,2}



- History of fever = +reported fever in past 14 days. Recent infection = +RDT result (rapid diagnostic test). Both for children aged 6-59 months.
- Urban/rural classifications are from each survey; generally a rural cluster has pop. <5000. Large city = pop. >750,000. Large city data was omitted for n of <50 fever cases.

Discussion

- MIS surveys typically include a sizeable number of residents of large cities, randomly chosen with scientific probability sampling. Thus, MIS data can be used to estimate key indicators at sub-national and national levels. For a given country, precision may be limited by under-sampling of metropolitan areas, microscopic technique, seasonality, and/or the accuracy of urban-rural classifications of clusters.
- Results are consistent with published works on urban malaria transmission, prevalence in children, and causes of febrile illness [2-6]. The dramatically reduced malaria transmission and prevalence in cities has been attributed to changes in environment (i.e. loss or pollution of *anopheles* breeding and resting sites) and human behavior (e.g. installation of screening and use of insecticides, bed nets, or medications).
- Yet public health and clinical decision-making does not consistently reflect these marked urban/rural differences. National planning documents commonly state that malaria is endemic throughout the country. For example, only 6 of 15 recent Global Fund malaria proposals from SSA acknowledged that transmission is low in large cities [10].
- National surveys show clearly that large cities represent an important exception and deserve to be highlighted. The findings suggest that
 - rural areas should be considered for prioritization in large-scale prevention efforts, such as insecticide treated bed nets;
 - in many countries, urban areas should be prioritized for universal testing of suspected malaria cases, especially in the large cities.

Conclusion

- Geo-spatial analysis of national household survey data from 2010-2012 demonstrated that the malaria prevalence in children 6-59 months was less than 5% for 16 of the 20 large cities for which data was available.
- Africa is rapidly urbanizing, and decision makers require additional evidence regarding the burden of malaria in the urban centers. Existing data from malaria indicator surveys can be used to document the substantially lower prevalence of malaria in specific large cities.
- These findings will help policy makers, programmers and clinical workers in each country to improve management of febrile illness, adjust malaria control priorities, and strength monitoring and research, with an eye on the contrasting needs of urban vs. rural populations.

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