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Prevalence of Malaria among Patients Attending Public Health Facilities in Maputo City, Mozambique

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Abstract. We conducted a health facility-based survey to estimate the prevalence of malaria among febrile patients at health facilities (HFs) in Maputo City. Patients answered a questionnaire on malaria risk factors and underwent malaria testing. A malaria case was defined as a positive result for malaria by microscopy in a patient with fever or history of fever in the previous 24 hours. Among 706 patients with complete information, 111 (15.7%) cases were identified: 105 were positive for *Plasmodium falciparum* only, two for *Plasmodium ovale* only, and four for both *P. falciparum* and *P. ovale*. Fever documented at study enrollment, age ≥ 5 years, rural HF, and travel outside Maputo City were statistically significantly associated with malaria by multivariate analysis. We found a high prevalence of laboratory-confirmed malaria among febrile patients in Maputo City. Further studies are needed to relate these findings with mosquito density to better support malaria prevention and control.

BACKGROUND

In recent years, Mozambique has received unprecedented funding for malaria control from various sources, notably the Global Fund to Fight AIDS, Tuberculosis, and Malaria; and the United States President's Malaria Initiative.[1,2] Despite the high availability of resources, efforts should still be made to determine areas at increased risk of malaria transmission so interventions can be targeted and funds used efficiently. Therefore, evaluations to determine the risk of malaria transmission in different areas of the country are necessary.

Malaria transmission is perennial in Mozambique with an annual peak in November through April. Most of the population lives in areas of meso- and hyperendemic transmission. A malaria indicator survey (MIS) conducted in June and July 2007 showed national malaria parasite prevalence among children < 5 years of age of 38.5% by microscopy. Parasite prevalence was highest in the central provinces (44.8%) and lowest in the southern provinces (27.7%).[3] Maputo City, the capital of Mozambique, is an independent administrative unit of the country, is considered the 11th province in Mozambique, and is divided into five administrative districts. Maputo City is at the southernmost tip of Mozambique at a latitude of 25° 57′ 55″ and a longitude of 32° 35′ 21″ with average precipitation ranging between 750 and 1,250 mm/year. Mangroves with fresh water swamps and marshes are the predominant vegetation in the area. The 2007 Mozambican census documented 1,099,102 inhabitants in an area of 34,769.3 hectares, or 31.6 persons per hectare.[4]

Although the 2007 MIS documented a parasite prevalence of 5.7% among children < 5 years of age in Maputo City, a total of 149,088 malaria cases in all age groups, most of which were laboratory confirmed, were reported in Maputo City in 2008 by the routine health information system.[3] Despite the limited information on true malaria prevalence, Maputo City has been considered to have low malaria transmission potential relative to the rest of the country, and malaria control efforts in the city have focused so far on indoor residual spraying (IRS), while insecticide-treated bednets (ITNs) have been distributed in other parts of the country. We conducted a rapid urban malaria assessment (RUMA) within Maputo City limits in March and April 2009 to better characterize malaria epidemiology in this area. The objectives of this assessment were to determine the prevalence of laboratory-confirmed malaria parasitemia among febrile patients presenting to public health facilities (HFs) during peak malaria transmission season; evaluate risk factors for malaria illness, including travel history; and identify areas within Maputo City with elevated risk of malaria transmission. Results from this survey will ultimately assist organizations working in malaria control to determine the need for malaria control efforts within the city.

METHODS

Study sites and survey teams. All public outpatient HFs were selected to participate in this survey with the exception of two large urban hospitals and one HF in a prison because they were major reference centers in town and inaccessible to survey teams, respectively. For the purposes of this evaluation, selected HFs were categorized into urban, peri-urban, and rural based on distance from city center and suburban administrative boundaries. Urban HFs were located in the center of the city within a radius of ~2 miles from the Central Hospital, which was considered the city center; peri-urban HFs were those located between 2 and 5 miles from the Central Hospital; and rural HFs were beyond the peri-urban limits up to the boundaries of Maputo City. We were able to include the outpatient department of hospitals and different types of health centers as categorized by the Ministry of Health in Mozambique. Hospitals have the highest levels of medical capacity with medical doctors, wards for in-patient admission, laboratory and radiology services, running water, and electricity. Health centers range from facilities staffed by a trained nurse where there is running water, electricity, and functioning laboratories (Type A) to those staffed by a medical technician and no running water or electricity (Type C).

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A total of 12 interviewers and three laboratory assistants, all fluent in Portuguese and able to converse in other local languages, collected data for this survey. After training on the survey methodology, data collection tools, and malaria rapid diagnostic test (RDT) and blood slide preparation, survey staff was divided into three teams, each comprising a team leader, three nurses or nurse assistants, a laboratory assistant, and a driver. Each team was responsible for visiting ~10 HFs, one per day, over a 2-week period.

Survey procedure. We implemented the RUMA protocol previously described.[5] In brief, teams arrived at HFs in the morning close to the opening hours and conducted the survey during the whole working day. Patients seeking care from the outpatient departments of selected HFs were screened by members of the survey team for eligibility and recruited to participate. Inclusion criteria consisted of patients with documented fever (axillary temperature ≥ 37.5°C) or a history of fever in the previous 24 hours, those presenting to the HFs for the first time for the current illness, and those who weighed more than 5 kg. Patients with signs or symptoms of severe malaria requiring hospitalization were excluded from the survey. After the screening, all eligible patients were read a brief consent in Portuguese and were enrolled in the evaluation if the patient or patient's guardian consented.

A standardized questionnaire was administered to consenting patients. This included demographic characteristics, malaria signs and symptoms, malaria risk factors, bednet ownership, household IRS in the past year, antimalarial treatment before seeking care at the HF, location of residence, and recent travel history. A finger-prick blood sample was collected for an RDT (ICT Malaria P.f., ICT Diagnostics, South Africa), and thick and thin blood smears. The RDTs were performed according to the manufacturer's directions, and patients with positive RDTs were treated according to national guidelines with artemether-lumefantrine by study staff. Regardless of RDT results, patients were then referred to HF staff for follow-up and evaluation.

Thick and thin smears were stained on the same day at the Parasitology Laboratory at the Instituto Nacional de Saude of Mozambique. Smears were read by two independent microscopists who were blinded to each other's result. Slides were examined using 100× magnification, and malaria positivity and speciation were determined. Trophozoites and gametocytes were counted per 500 white blood cells, and we estimated parasitemia assuming 8,000 white blood cells/μL. In cases where the two readings differed by positivity, species, or > 50% of parasitemia, a third reader examined the slide. The geometric mean of the two closest parasitemia results was used as the final reading for each slide. We defined a malaria case as the presence of asexual parasites in an HF patient with fever (axillary temperature ≥ 37.5°C) or history of fever in the previous 24 hours.

Statistical methods. We double entered data into an EPI Info 2000 (United States Centers for Disease Control and Prevention [CDC], Atlanta, GA) dataset to perform initial data cleaning. We used SAS, version 9.2 (SAS Institute, Cary, NC) for data analysis. Descriptive statistics and crude odds ratios (ORs) were calculated to initially evaluate variables associated with laboratory-confirmed malaria. Variables with a P value ≤ 0.20 were then included in multivariate logistic regression analyses. Clustering at the HF level was accounted for in both the univariate and multivariate analyses.

Ethics. This protocol was approved by the ethics committee of the Mozambican Ministry of Health. It was deemed nonresearch and granted approval as public health evaluation by the Institutional Review Board at CDC (reference no.: 990150).

RESULTS

Health facility and patient characteristics. Of the 30 HFs eligible to participate in this evaluation, we were unable to collect information in two; one facility was closed during the time of the survey and the other did not have any patient who met the eligibility criteria on the day of the visit. Therefore, we included 28 HFs; 10 urban, 7 peri-urban, and 11 rural. A total of 4,604 people presented as outpatients at these 28 HFs during the survey teams visits; 779 (16.9%) patients were considered eligible to participate in the survey, and 706 (90.6%) of those consented and provided complete clinical and laboratory information. Two hundred eighty-one (39.8%), 203 (28.8%), and 222 (31.4%) patients were seen at urban, peri-urban, and rural HFs, respectively.

The demographic characteristics of enrolled patients per HF stratum are shown in Table 1. Among all patients, 404 (58.0%) were female; peri-urban HFs had the highest proportion of female patients seeking care (62.0%). Patient's mean age was 20.5 years (range: 3 months–84 years), and 209 (29.6%) patients were children < 5 years of age. Finally, 331 (47.4%)

Table 1
Selected characteristics among enrolled patients, Mozambique (N = 706 patients)*

Variable	Urban HFs Value (%) (95% CI)	Peri-urban HFs Value (%) (95% CI)	Rural HFs Value (%) (95% CI)	Total Value (%) (95% CI)
Female gender	51.6 (45.1–58.2)	62.4 (56.5–68.3)	62.0 (56.9–67.1)	58.0 (54.3–61.8)
Age (mean, years)	18.1 (4.0–22.5)	22.8 (12.3–27.2)	21.6 (8.7–28.5)	20.5 (12.6–23.4)
Children < 5 years of age	35.6 (20.7–50.5)	21.8 (7.7–35.9)	29.3 (12.5–46.1)	29.6 (21.5–37.8)
Documented fever at enrollment	30.8 (25.2–36.5)	68.5 (52.5–84.4)	48.8 (36.7–61.0)	47.4 (39.1–55.7)
Work on or trip to a *machamba*	9.0 (4.6–13.4)	12.5 (6.0–19.0)	35.1 (17.2–53.0)	18.1 (11.1–25.1)
Any treatment of current disease	43.8 (38.1–49.4)	41.4 (30.3–52.4)	36.5 (29.9–43.1)	40.8 (37.0–44.6)
Bednet at household	61.8 (51.6–71.9)	53.0 (40.5–35.5)	44.8 (30.6–59.0)	53.9 (47.4–60.4)
Bednet hung the previous night	53.2 (44.3–62.1)	45.5 (35.2–55.9)	36.9 (25.5–48.2)	45.9 (40.4–51.4)
Sleeping under a bednet the previous night	48.9 (40.6–57.3)	39.1 (31.1–47.1)	35.3 (21.7–42.9)	40.9 (35.8–46.0)
Sleeping under an ITN the previous night	12.2 (7.1–17.4)	16.8 (8.3–25.3)	12.0 (8.3–15.6)	13.5 (10.5–16.4)
House close to water	14.3 (8.5–20.0)	17.2 (6.7–27.6)	18.0 (10.6–25.4)	16.3 (12.5–20.1)
Machamba at house	14.6 (7.7–21.6)	17.3 (7.5–27.2)	41.6 (28.4–54.7)	23.9 (17.0–30.8)
IRS at house	47.9 (39.9–55.9)	35.9 (23.6–48.1)	56.1 (41.9–70.3)	47.0 (40.5–54.5)

HF = health facility; CI = confidence interval; ITN = insecticide-treated bednet; IRS = indoor residual spraying.

patients had documented fever at admission, and 645 (92.1%) were residents of Maputo City.

Prior treatment. A total of 288 patients (40.8%) reported receiving treatment of any sort for the current disease before their visit to the clinic at the time of enrollment. Among those who received treatment, the most common class of medication taken was antipyretics, which was taken by 229 (79.5%) patients; followed by antibiotics (16 patients [5.6%]) and herbal treatments (15 patients [5.2%]). Sulfadoxine-pyrimethamine was the most commonly reported antimalarial and was used by 7 (2.4%) patients before the HF visit.

Laboratory results. Among the 706 enrolled patients, 111 (15.7%) cases were identified; 105 of *Plasmodium falciparum* only, two of *Plasmodium ovale* only, and four of both *P. falciparum* and *P. ovale*. No cases of *Plasmodium vivax* or *Plasmodium malariae* were identified. The RDTs were positive in 99 of the 111 patients, yielding a sensitivity of 89.2% (95% confidence interval [CI]: 82.2–96.2%). The RDT specificity was 97.0% (95% CI: 95.3–98.7%), because RDTs were negative in 577 of the 595 non-cases.

Risk factors for malaria. Twenty-eight laboratory-confirmed malaria cases (10.0%; 95% CI: 6.8–13.2%) were identified among 281 patients seen at urban HFs, 29 (14.3%; 95% CI: 6.3–22.3%) among 203 seen at peri-urban HFs, and finally 54 (24.3%; 95% CI: 14.0–34.6%) among 222 seen in rural HFs. There was a statistically significant difference in prevalence of malaria between rural and urban HFs ($P = 0.001$).

In addition, univariate analysis revealed that patients ≥ 5 years of age, who presented with documented fever at the HF, who lived close (< 250 m) to a *machamba* (plot of land used for subsistence farming in Mozambique), and who either worked in a *machamba* or accompanied caregivers while they farmed the field were all associated with documented malaria illness. Restricting analysis to patients who lived in Maputo City (645 patients), travel outside the city for at least one night in the previous 3 months was borderline statistically significantly associated with documented malaria illness (OR = 1.64; 95% CI: 0.99–2.7) when all HFs are considered together. When HF strata are considered separately, travel history was statistically significantly associated with malaria illness only for urban HFs (OR = 3.93; 95% CI: 1.56–9.89). Of note, malaria illness was present in 14 (6.9%) of 202 patients seen in urban HFs without travel history. Univariate analysis results are presented in Table 2.

Bednets and IRS. Three hundred seventy-nine (53.9%) patients lived in a household that had at least one bednet of any kind, and 321 (45.9%) lived in a household that had at least one bednet of any kind that was hung over a sleeping space the previous night. In addition, 285 (40.9%) slept under a bednet the previous night and 94 (13.5%) slept under an ITN the previous night (Table 1). Sleeping under a bednet of any kind or an ITN the previous night was not statistically significantly associated with not having malaria (Table 2). In terms of IRS, 318 (47.0%) lived in houses that had been sprayed. There was no difference in malaria status by living in a house that had received IRS ($P = 0.46$) (Table 2).

Multivariate analysis. We noted that, among patients who visited an urban HF, malaria parasitemia prevalence was higher among those who regularly either worked on or accompanied a caregiver to a *machamba* (25%) compared with those who did not go to such locations (8.7%). These differences in malaria parasitemia prevalence associated with going to a *machamba* progressively decreased for patients who attended peri-urban (24.0% versus 12.6%) and rural (24.7% versus 24.4%) HFs. The same difference in malaria parasitemia prevalence associated with having a *machamba* in the patient's residential property was observed among patients seen at HFs progressively distant from the city center. This suggests that the effect of going to a *machamba* or having one close to the house differed depending on whether the patient visited an urban, peri-urban, or rural HF.

Because it can be argued that working or accompanying the caregiver while he works in a *machamba* and having a *machamba* close to the house would be more likely in the rural HF strata in the first place, we decided to include only the HF stratum in the final multivariate model. In addition, we restricted the multivariate analysis to patients who were residents of Maputo City to be able to evaluate travel outside the city as a risk factor for documented malaria illness. Results of the final model are presented in Table 3. Age > 5 years, documented fever at enrollment, travel outside Maputo City, and rural HF were all statistically significantly associated with laboratory-confirmed malaria.

TABLE 2

Univariate analysis of selected variables and risk of malaria, Mozambique ($N = 706$ patients)

Variable	Odds ratio (OR)	95% CI	*P* value
Age group (≥ 5 vs. < 5)	1.99	1.21–3.25	0.007
Documented fever at enrollment	2.16	1.31–3.58	0.003
Residence in Maputo City	1.30	0.56–3.02	0.537
History of travel ($N = 645$)	1.64	0.99–2.73	0.056
House close to water	1.63	0.79–3.37	0.187
Machamba at house	2.66	1.72–4.10	< 0.0001
HF stratum (Peri vs. urban)	1.51	0.74–3.07	0.260
HF stratum (Rural vs. urban)	2.90	1.54–5.48	0.001
Work on or trip to a *machamba*	2.04	1.25–3.34	0.005
Bednet at household	1.01	0.66–1.55	0.975
Bednet hung the previous night	0.98	0.63–1.51	0.920
Sleeping under a bednet the previous night	0.87	0.55–1.40	0.577
Sleeping under an ITN the previous night	1.03	0.63–1.69	0.895
IRS at house	0.89	0.65–1.22	0.463

*CI = confidence interval; ITN = insecticide-treated bednets; IRS = indoor residual spraying; HF = health facility.

DISCUSSION

We found that a sizeable percentage of febrile patients visiting HFs throughout Maputo City had laboratory-confirmed malaria parasitemia. In addition, we demonstrated that malaria parasitemia among febrile patients was more commonly associated with older age, having documented fever at

TABLE 3

Multivariate analysis of variables and risk of malaria among patients who lived in Maputo City, Mozambique ($N = 645$ patients)*

Variable	Adjusted OR	95% CI	*P* value
Age group (≥ 5 vs. < 5)	2.23	1.26–3.97	0.006
Documented fever at enrollment	2.40	1.46–3.94	0.001
History of travel	1.82	1.08–3.07	0.025
House close to water	1.89	0.89–4.02	0.098
HF location (Peri vs. urban)	1.07	0.50–2.30	0.868
HF location (Rural vs. urban)	2.49	1.22–5.07	0.012

*OR = odds ratio; HF = health facility; CI = confidence interval.

enrollment, travel outside city limits, and visiting rural HFs. Our study also shows that even the prevalence of malaria parasitemia among febrile patients visiting urban HFs (10%) was also higher than anticipated and was present even in patients with no travel history. These results support the need for malaria prevention strategies, such as IRS and ITN distribution, to be expanded in the capital of Mozambique.

Malaria transmission in urban settings is considerably variable in endemic countries in Africa. As sub-Saharan countries usually do not scale up malaria control strategies uniformly within their territories, malaria prevalence among febrile patients will likely vary within each country, particularly between urban, peri-urban, and rural areas. A recent study in Luanda, capital of Angola, showed that 3.6% of febrile patients presenting to HFs had laboratory-confirmed malaria.[6] However, the prevalence of malaria was above 20% among febrile patients visiting HFs in Ouagadougou.[7] These differences in malaria prevalence have major programmatic implications for the implementation of malaria prevention and control measures. In low-prevalence settings, efforts should be made to follow the World Health Organization (WHO) recommendations for consistently confirming malaria infection with laboratory tests, either RDTs or microscopy, with subsequent timely provision of appropriate treatment to positive patients.[8,9] In such areas, it may seem inappropriate to rely on presumptive treatment of malaria, as many of the febrile patients will indeed not have malaria and other causes should be investigated and treated.[10] In areas with high prevalence of malaria infection and higher transmission burden, in addition to proper case management of febrile patients, efforts toward malaria prevention, as that provided by an integrated vector control management, should be encouraged

The reasons behind the different malaria transmission risks in urban settings in Africa are complex. In some places, urbanization has led to a decrease in malaria transmission risk, likely because of changes in vector habitat, use of prevention methods, and greater access to effective and timely treatment.[11] In other areas, poor housing and sanitation likely led to an increase in human-vector contact.[12] The high prevalence of malaria among febrile patients may be related to a disorganized urbanization process and/or possible changes in vector behavior and habitat. Unfortunately, our survey was not designed to evaluate mosquito behavior and presence of breeding sites, but previous reports in Maputo have shown that malaria risk is associated with proximity to breeding sites and decreases steeply after only a few hundred meters.[13] Therefore, malaria control in the urban setting may require the adoption of multiple, spatially targeted prevention strategies and not rely exclusively on appropriate case management. Despite successful experiences in controlling malaria relying heavily on IRS in some areas of Mozambique, other complementary strategies, including universal distribution of ITNs or integrated vector control, might be needed to further decrease malaria transmission in the city.[14,15] In addition, environment management of surface water may also be needed as part of a comprehensive malaria prevention and control plan in this context.[12,16]

The low percentage of patients who slept under ITNs or lived in houses that had been sprayed may indicate a relative lack of access to effective prevention measures in Maputo City compared with other parts of the country[3]; unfortunately, this evaluation was not designed to accurately estimate these indicators. Taking into account that HF-based surveys tend to overestimate access to prevention strategies, actual coverage may be even lower if assessed by the globally recommended household survey approach.[17] The 2007 Mozambique MIS indeed showed that in Maputo City the rate of children < 5 years of age and pregnant women sleeping under an ITN the previous night was < 9% and the percentage of houses being sprayed in the last 12 months was 52.4%.[3] This relatively low coverage with prevention strategies may be partially explained by the belief that transmission within the city limits was low and the consequent limited scale-up of malaria control strategies in the city. The findings of our study should be considered as evidence of considerable malaria transmission in Maputo City and should support the broader use of prevention strategies within the city limits.

When we consider only the patients who visited urban HFs in Maputo City, documented malaria illness was more common in those who had a *machamba* on the premises of their houses and those who worked on or accompanied the caregiver to a *machamba.* This finding speaks to malaria transmission associated with possible mosquito breeding sites in those subsistence farming plots or exposure while farming the land. It is not uncommon that workers and their companions spend the night in the *machambas*, sleeping either outdoors or in temporary housing during the rainy season, when most of the farming occurs. In Dar es Salaam, however, mosquito breeding sites associated with agricultural practices accounted for only one-fifth on all breeding sites in the city; therefore, other factors may contribute to the urban transmission of malaria in Africa.[18] Previous reports showed that *Anopheles funestus* and *Anopheles arabienses* are the most common vectors in areas surrounding Maputo City.[19] Both species have proven to have considerable endophagic behavior, which favors the benefits of IRS and ITNs as protective measures.

Our evaluation underscores the importance of malaria laboratory testing among febrile patients presenting to HFs. According to the WHO guidance, Mozambique is in the process of adopting a case management policy that recommends all cases of suspected malaria be confirmed by laboratory testing.[20,21] This policy serves at least two purposes: reduce unnecessary use of artemisinin-based combination therapy and exclude malaria among non-malaria febrile patients, allowing for other causes of fever to be investigated and treated. Overtreatment of malaria is not only an economic concern; it has been proposed that restricting antimalarial use to laboratory-confirmed cases will also delay the emergence and spread of resistance to artemisinin derivatives and their partner drugs.[22] Of even more concern is the issue of labeling febrile patients with malaria when indeed they do not have malaria. Some studies have shown a reduction in the prevalence of malaria parasitemia among febrile patients over the last decades and also investigated the causes of fever in children, which is commonly associated with respiratory infections.[23–25] The labeling of all febrile patients as having malaria can have severe consequences as the underlying disease would not be properly identified and treated.[25]

Much concern was brought to the malaria community about the use of RDTs alone as a means to reduce unnecessary malaria treatment in febrile patients. There have been concerns about low RDT sensitivity when compared with microscopy, frequently considered the gold-standard laboratory test for malaria. Some studies have shown variable sensitivity and

specificity for RDTs when implemented as part of routine care.[26,27] Recent publications, however, have provided comprehensive information on the performance of RDTs, and this information should be taken into account in selecting the appropriate RDTs for each specific epidemiologic setting.[28,29] In addition, adequate healthcare worker training and supervision is strongly recommended to achieve and maintain high performance of these tests.[27,30,31] In our study, we found the sensitivity of ICT Malaria P.f. to be comparable to high-quality microscopy. It is important to remember that our study staff was trained in the use of RDTs and good performance of these tests is highly associated with appropriate training and supervision of healthcare workers and laboratory staff.[30,32]

This study has several limitations. First, it was an HF-based survey and, by limiting the information on malaria prevalence to only patients seen at HFs, we may have poorly estimated the true burden of malaria in Maputo City. The study, however, shows considerable malaria prevalence in febrile patients seen at HFs from all three strata. Second, the survey took place over a short period of time and, for this reason, was not suited to assess the burden of malaria in different transmission seasons. Finally, we were unable to evaluate the place of residence of patients and used HF as a proxy for place of residence, where malaria infection is likely to have occurred.

In summary, we documented a relatively high prevalence of malaria parasitemia among febrile patients seen at public HFs in the capital of Mozambique. Malaria infection was common even in HFs in the more urban parts of town. These results differ from other capital cities in sub-Saharan Africa, such as Luanda, and should be taken into consideration in the planning and implementation of malaria prevention and control strategies. Further studies are needed to confirm our findings and to relate human data to mosquito density and behavior.

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