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Epidemiology of Malaria in Urban Area (Adzopé City, Côte D' ivoire)

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Abstract: Two transversal surveys (dry and rainy season) in two districts (Tsassodji and Port-bouët) were carried out due to the presence of valleys, their exploitation for farming and their geographical situation in the town of Adzopé which lies 108 km to the east of Abidjan. The study was carried out from 2006 to 2007 sampling 577 children aged from 6 months to 14 years. During each visit, thick blood sample of these children were collected for analysis. The prevalence of *P.falciparum* infection among children of 2 to 9 years (68.5% 95% CI: 64.4-72.4) classified Adzopé district as a hyper-epidemic malaria area. Of the 577 samples children, 324 (56.1%) were asymptomatic (axillary temperature < 37°5) with the presence of parasitaemia, while 177 (30.6%) had fever (temperature $\geq$ 37°5). Among the enrolled children, 105 (18.2%, 95% CI: 15.2-21.6) of them had fever. Malaria attack accounted for 12.5% (72 of the 577 children); 40.7% of febrile children. The risk of malaria was significantly higher among children below five years and varies according to district of residence range from 7.8 % (Tsassodji) to 19.6% in Port-bouët [OR=2.88, 95%CI: 1.73-4.80]. The use of mosquito net varied from 11.2% Tsassodji to 13.9% in Port-bouët. The study showed that the risk of malaria increases with the utilization of the valleys for farming in urban areas.

Key words: Mosquito net • Urban malaria • Children • Adzopé district • Côte d'Ivoire

INTRODUCTION

Malaria remains one of the most serious global health problems. There are an estimated one million deaths, with nearly 75% occurring in children living in Sub-Saharan Africa (SSA) [1] and 365 millions cases each year [2].

The urban population in Africa is growing at an annual rate of 3.5%, more than three times that of the rural population and it is estimated that by 2025, about 50% of the world population will live in urban areas [3]. This has adversely affected environmental condition and encourages diseases. Malaria in urban area is likely to increase as rapid urbanization will result in the majority of Africa's population living in cities in the near futures [4] and malarial epidemiology in urban area will be a threat to those in rural areas [5].

Some years back, malaria was considered as a rural disease in Africa. Most of malaria researches have been done in rural areas and the strategies including vector control and the diagnosis and the treatment of infection had been tailored to the urban contest [6, 7]. Recently, there has been a growing interest in the study of malarial epidemiology, with the aim of developing specific control strategies [6, 8, 9]. So, clearly detailed information on malarial epidemiology in urban area is urgently needed.

In Côte d'Ivoire, where malaria is the major reason for consultations at heath centers, with 30 to 40% of all consultations [10, 11], few studies have been conducted. In 1994 in Bouaké, Dossou-yovo *et al* [12] reported the relationship between farming and peri-urban transmission of malaria. In Abidjan a standard study protocol for Rapid Urban Malaria Appraisal (RUMA) was developed in 2002 and showed that rapid urbanization has been responsible for malarial epidemiology in Abidjan [11].

The current case study was conducted in Adzopé, a locality where malaria epidemic is very common, pilot area for the National Malaria Control Programme for evaluation of chemo-sensitivity of malaria and impact of insecticide treated mosquito net. It is aimed to describe the epidemiology of malaria in urban area in a region with higher transmission due to *Anopheles gambiae s.l* (Adja A.M., unpublished data). A comparison was made

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between two districts (a peripheral and a central district) with data provided from dry and rainy season. The malaria effect on children aged six month to 14 years old has been studied in terms of prevalence and density of malarial infection, of critical malaria attack.

MATERIALS AND METHODS

Study Population and Site: The study was conducted in Adzopé (lat. 06°06´N and long. 03°51´W); a city situated in a forest area, approximately 108 km to the east of Abidjan the economic capital city of Côte d'Ivoire. According to 1998 census, Adzopé had 43,821 inhabitants formed by aboriginal population and a small foreign community. There are four seasons, peak rainfall occurs between March and July with a secondary peak between September and November; and two dry seasons occur from July to September and December to March. The annual rainfall is 1,789 mm. Two districts of Adzopé were chosen for this study, due to the presence of valleys and there geographical situation in the town. Tsassodji a central district without farming (no water control) and Port-bouët a peripheral district where urban farming takes place (Fig. 1). This study focuses only on malaria disease in children between six months and 14 years of age.

Data Collection and Laboratory Examination: Two cross-sectionals surveys were conducted in 2006 (rainy season) and in 2007 (dry season) and the incidence of malaria was measured during rainy and dry season to take seasonal variation. A mobile health team including a medical doctor for basic medical examination and a laboratory technician for blood sampling were present in the areas at the time of the survey. They visited children in all households of the two districts. Demographic information of each selected child including name, sex, age and district of residence were recorded on morbidity questionnaire. Thereafter, medical and physical examination were carried out to assess children general health condition. Axillary temperatures were recorded and temperature ≥37.5°C was considered to be a fever. Blood samples were collected by fingerpicks for thick and thin smears preparation for malaria parasite quantification and identification. Sick children were treated according to the medical diagnosis made by the medical doctor and when malaria attack was suspected, patient was treated with Arsucam® (artesunate+amodiaquine) for 3 days in conformity with National Malaria Control Programme.

Laboratory Procedures: Thick smears were Giemsa® stained in the field and examined under an oil immersion objective at X 1,000 at the Institut Pierre Richet in Bouake (temporary located in National Institute of Public Health in Abidjan). Parasite density was estimated by counting the number of asexual stages of *Plasmodium falciparum* per 200 white-blood cells and calculating parasites per µL, assuming a white blood cell count of 8,000 cells per µL. A smear was declared negative after reading 100 high power fields. Cross-check quality control was done on a randomly selected representing 10% of all thick smears by another laboratory technician.

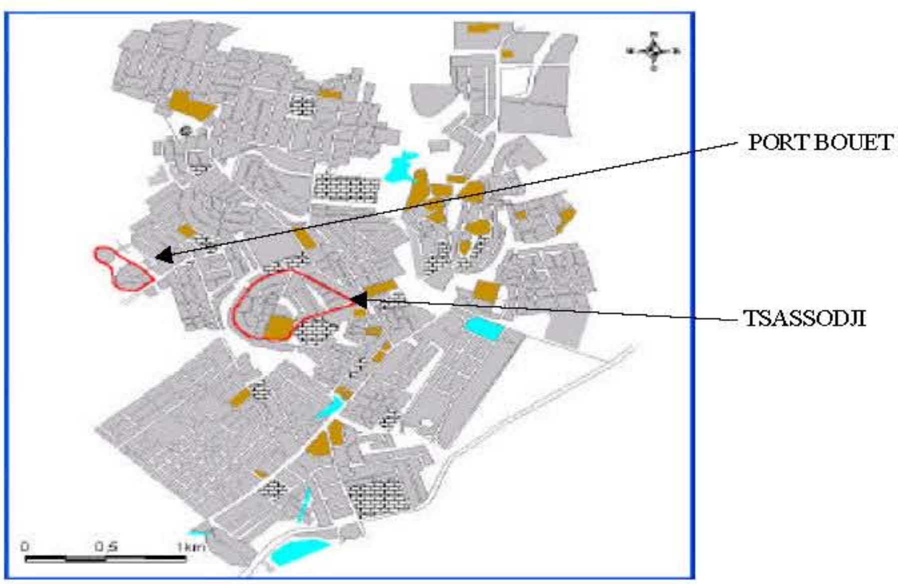

Fig. 1: Map of Adzope including study areas

Statistical Analysis: An Excel database was created with the data gathered and the EPI Info (version 6, 1995) statistical software was used to analyze the data. Significance was chosen as p-values less than 0.05.

Three dependent variables were analyzed: i) the prevalence of *P. falciparum* infection, ii) *P.falciparum* parasite density (only in children tested positive, as continuous variable by taking the log of the density); and iii) the prevalence of malaria attacks. Malaria attack was defined by the presence of fever (axillary temperature ≥ 37.5°C) with any parasitaemia.

Age, season (dry and rainy), district of residence (Tsassodji and Port-bouët) and gender (male/female) were used to analyze these dependent variables. The age variable was broken into three classes of equivalent size: 0-4years, 5-9years and 10-14years. A descriptive analysis of the two districts was carried out taking account of the age of children, season, gender, use of mosquito net and presence of *P. falciparum* parasitaemia and parasite density. Bivariate analyses were then performed and all variables with p-value less than 0.05 were entered into multivariate model. Significance was determined using likelihood ratio tests. Logistic regression models were employed for the binary indicators and linear regression models for parasite density.

Ethical Review: The protocol for this study was approved by the ethics committee of Ivorian Ministry of Public Health through the National Institute of Public Health in Abidjan, which is responsible for co-coordinating medical research in Côte d'Ivoire. Each head of family (father or mother), or the legal guardian of the child, gave informed consent before his/her inclusion in the study.

RESULTS

This study involved a total of 577 children aged of 6 months to 14 years on the two cross-sectional surveys, with at least 421 children census in rainy season and 156 in dry season. The distribution of population sample by age and by district is shown in Table 1. The children aged of 5 to 9 years were the most numerous, representing 41.4% of the total samples. Parasitaemia was detected in 396 children (68.6%). The use of mosquito net varied from 11.2% (39 at Tsassodji) to 13.9% (32 at Port bouët) according to the districts (Table 1) and only 36.6 % (26) of these bed net were treated with insecticides.

The classification of population by age, by district of residence and by season, the parasite density in children tested positive, the prevalence of infection and the use of mosquito net are shown in Table 1.

Prevalence of Infection: The main species observed in all infection was *P. falciparum*, 100% of general plasmodic index. Absence of *P. malariae or P. ovale* was noticed in tested blood samples. The plasmodic index of children 2 to 9 years of age was high, 68.5%. The season, district of residence and age were significantly associated with the prevalence of infection in bivariate analysis (Table 2). Children below five years old were more infected than 5-9 years (OR:0.53 95%CI:0.33-0.81 P=0.04) and 10-14 years old children (OR:0.57 95% CI:0.35-0.92 P=0.023). However the prevalence of infection was sensibly the same between these two groups respectively 64% and 65.8%. Therefore, no significant difference between male and female was found (OR: 0.86; 95%CI: 0.6-1.22), p=0.389). According to the multivariate random-effect

Table 1: Characteristics of the studied area

Districts	Tsassodji	Port-Bouët
Number of children aged from 6 months to 14 years	347	230
Number of children during dry season	103	53
Number of children during rainy season	244	177
Presence of *P.falciparum* parasitaemia % (95%CI)	56.2 (50.8-61.5)	87.4 (82.4-91.4)
P. falciparum density among positive children (/µl)		
Geometric mean (95%CI)	977 (726-1314)	750 (613-917)
Age (%)		
0 -4 years	106 (30.6)	77 (33.5)
5-9 years	142 (40.9)	97 (42.2)
10-14 years	99 (28.5)	56 (24.3)
Sex (%)		
Female	175 (50.4)	127 (55.2)
Male	172 (49.6)	103 (44.8)
Used of bed net (%)		
No	308 (88.8)	198 (86.1)
Yes	39 (11.2)	32 (13.9)
No. of fevers	52	53
Prevalence % (IC)	15 (11.5-19.3)	23 (17.8-29.0)
No. of malaria attack	27	45
Prevalence % (IC)	7.8 (5.3-11.2)	19.6 (14.6-25.3)

Table 2: Prevalence of *falciparum* malaria infection and parasite density

		Prevalence of infection				Parasite density		
Variables	Modality	% (95CI)	OR	% (95CI)	P-value	Geometric mean (95%CI)	Multiplicative factor	P-value
Age	0-4 years	77.0 (70.3-82.9)	1		-	1271 (923-1751)	1	
	5-9 years	64.0 (57.6-70.1)	0.53	(0.33-0.81)	0.004	792 (617-1016)	X 0.62	0.024
	10-14 years	65.8 (57.8-73.2)	0.57	(0.35-0.92)	0.023	552 (384-793)	X 0.43	0.0003
Season	Dry	55.8 (47.6-63.7)	1			332 (253-434)	1	
	Rainy	73.4 (68.9-77.5)	2.2	(1.5-3.2)	0.0001	1115 (907-1371)	X 3.36	<0.00001
Sex	Male	70.2 (64.7-75.4)	1			898 (702-1148)	1	
	Femme	66.9 (61.1-72.4)	0.86	(0.60-1.22)	0.389	807 (622-1047)	X 0.90	0.600
District	Tsassodji	56.2 (50.8-61.5)	1			977 (726-1314)	1	
	Port-Bouët	87.4 (82.4-91.4)	5.4	(3.46-8.42)	< 0.00001	750 (613-917)	X 0.77	0.147

Table 3: Prevalence of *Plasmodium falciparum* infection according to the age, the district and the season

			Prevalence of infection	
Variable	Modality	OR	95%CI	P-value
Age	0-4 years	1		
	5-9 years	0.52	0.33-0.83	0.006
	10-14 years	0.61	0.36-1.01	0.055
District	Tsassodji	1		
	Port-Bouët	5.37	3.42-8.43	<0.000001
Season	Dry	1		
	Rainy	2.06	1.36-3.11	0.0006

Table 4: Prevalence of fevers and malaria attack

		Prevalence of Fevers				Prevalence of malaria attack		
Variables	Modality	% (95CI)	OR	(95%CI)	P-value	% (95CI)	OR (95%CI)	P-value
Age	0-4 years	21.3 (15.6-28.0)	1			17.5 (12.3-23.8)	1	
	5-9 years	17.6 (13.0-23.0)	0.79	(0.48-1.28)	0.334	10.9(7.2-15.5)	0.58 (0.33-1.01)	0.052
	10-14 years	15.5 (10.2-22.2)	0.68	(0.39-1.18)	0.172	9.0 (5.0-14.7)	0.47 (0.24-0.91)	0.026
Season	Dry	29.5 (22.5-37.3)	1			11.2 (8.4-14.7)	1	
	Rainy	14.0 (10.9-17.8)	0.39	(0.25-0.60)	< 0.00001	16.0 (10.6-22.7)	0.66 (0.39-1.11)	0.118
Sex	Male	15.1 (11.1-19.9)	1			15.1 (11.2-19.6)	1	
	Femme	21.1 (16.6-26.1)	0.67	(0.43-1.02)	0.064	97 (6.5-13.8)	0.62 (0.36-1.01)	0.054
District	Tsassodji	15.0 (11.5-19.3)	1			7.8 (5.3-11.2)	1	
	Port-Bouët	23.0 (17.8-29.0)	1.67	(1.11-2.60)	0.014	19.6 (14.6-25.3)	2.88 (1.73-4.80)	< 0.00001

logistic regression model (Table 3), the prevalence of infection was higher during the rainy season than dry season (OR: 2.06 95%CI: 1.36-3.11). Children had two times higher possibility of being infected in rainy season than dry season. No significant level was found between young children (below 5 years) and the oldest children (9 to 14years). According to the district of residence, the prevalence of infection was higher in Port-bouët than Tsassodji (OR: 5.37 95% CI: 3.42-8.43), there was five time higher possibility of being infected when living in this district.

Parasite Density in Positive Children: The geometric mean of parasitaemia among children was 850 parasites /µL (range 40-592,800 parasites/µL) in this study. The season and the age of children were significantly associated with parasite density in bivariate analysis (Table 2). Parasite density was high in six month to four years old children (geometric mean parasite density 1,271 parasites/µL, range 40-592,800 parasites/µL) and decreased steadily with age to level off in oldest children (10-14years) [geometric mean: 552 parasite/µL, 95%CI: 384-793]. The parasite density was also higher in the rainy season 1,115 parasites/μL (density multiplied by 3.36) than dry season, 332 parasites/μL. District of residence and gender (male/female) were not significant variables for explaining parasite density.

Prevalence of Fever and Malaria Attacks: Of the 577 enrolled children in this study, only 18.2% (105 children) had fever. The proportion of fever varied from 15% (95 %CI: 11.3-19.3) in Tsassodji to 23% (95%CI: 17.8-29.0) in Port-bouët. However, the proportion of fever in rainy season (14.0%) was lower than dry season (29.5%). Season and district of residence were significantly associated with fever in bivariate analysis (Table 4). There were no significant differences between male and female and between age classes. According to malaria definition, of the 577 children, only 72 (12.5%) attacks were identified and all ages are concerned. But, of the 421 children enrolled in rainy season, 47 malaria attacks (11.2%) were highlighted, while in dry season 25 children had malaria (16%). The age of children and district were significantly associated with malaria attacks in bivariate analysis (Table 4).

DISCUSSION

This study was designed to obtain data on malariometric indices in two districts of Adzopé city. It was aimed at providing baseline epidemiological informations. *P. falciparum* was the predominant species accounting 100% of all malaria attacks. Previous study in Côte d'Ivoire have reported a predominance of *P.falciparum* [10, 13, 14], thereby Djaman *et al* [13] reported 97.7% of *P.falciparum* infection rate and Yavo *et al* [10] also reported 98% in a study carried out in Agou, a small city near Adzopé.

Malaria endemic is classically defined by surveys of parasite prevalence, Adzopé would be considered hyper-endemic area as prevalence is above 50% in children of 2 to 9 years of age, given prevalence around 68.5%. Although, young children obviously have little surface exposed to mosquito bites and are consequently less exposed to malaria transmission [15], six month to four years old group had the highest prevalence of infection (77%) and parasite density (geometric mean :1,271 95% CI:923-1751). Moreover, children living in Port-bouët Vridi had five times higher possibility of being infected with *P. falciparum* (OR=5.37, 95%CI: 3.42-8.43). This result agreed with entomological data which showed that malaria transmission was three times higher in peripheral district (Port-bouët) than central district (Tsassodji) [Adja, unpublished data]; they reported continuous transmission with high entomologic inoculation rates (EIR), 394 infective bites per person per year. Parasite density were associated with seasonal variation and decreased steadily with increasing age. Children below five years had highest parasite density, indicating weaker immunity and higher vulnerability to malaria. High prevalence and parasite density could be explained by the intense malaria transmission due to *Anopheles gambiae* s.l., the main malaria vector in Adzopé (Adja, unpublished data).

In this study malaria was defined as fever with parasitaemia at any density. According to this definition 72 malaria attacks were recorded, with no seasonal variation (OR=0.66 95%CI: 0.39-1.11 p=0.118). Moreover, all age classes have been affected, thus Port-bouët were more affected than Tsassodji (OR=2.88, 95%CI: 1.73-4.80). The high prevalence of malaria attack in Port-bouët was possibly due to his peripheral situation where the environment was similar to rural areas. Moreover, a number of farming areas present in Port-bouët constituted breeding site of malaria vectors *An.gambiae* s.l. Several studies have shown that urban farming was associated with higher risk of malaria transmission [16-19], thus Mathys *et al* [19] found that urban farming created additional breeding sites for anophelines in the city environment and that malaria risk was affected by the type of farming practiced. However, Keating *et al* [20] found no relationship between household level farming and breeding sites in a recent study in two cities in Kenya.

Data presented here also showed weak mosquito net coverage. Among the sampled population, mosquito net use was reported by 12.3% with 4.5% use of an insecticide treated net (ITN). Although the effect on malaria transmission was not performed, the use of ITNs in this city still remains far below the Abuja target. In fact, to improve malaria control, increased ITN use was prioritized by African leaders at the Push Back Malaria Summit in Abuja with goal of 60% of those at risk of malaria, especially children under five years of age and pregnant women, free access to ITNs by 2005.

CONCLUSION

This study was designed to obtain data on malaria epidemiology in Adzopé city and measures the impact of urban farming in malaria transmission which could be affected by different factors, some of which could not be fitted or explain in this paper and therefore needs more explaination.

P. falciparum was the main malaria parasite; and the highest prevalence of infection conferred in Adzopé city hyper-endemic area. The district of Port-bouët was more marked by the determinant of malaria transmission in term of prevalence and parasite density of infection and also in term of prevalence of malaria attack compare to Tsassodji. The increased malaria risk in urban farming areas would have to be weighed against the benefits that rural vegetable production brings to the households and the local economy. The way forward in such a scenario might be to advocate adjustments in irrigation practices in combination with increased protection from mosquito bites for the population affected rather than discouraging the setting up of irrigated urban farms.

These data will help National Malaria Control Programme to target control strategies aimed at reducing malaria morbidity and mortality in this population. Use of insecticide treated net is recommended and, its distribution should be promoted.

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