

STUDIES OF MALARIA TRANSMISSION RISK FACTORS IN A TIME OF MILITARY-POLITICAL CRISIS IN BOUAKE URBAN AREA (IVORY COAST)

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Abstract

In order to assess the risk of malaria transmission to which populations are exposed in a time of war in besieged areas, studies were conducted between April and June, 2008, in a district of Bouaké, a town in the humid savannah of the central Ivory Coast. This study's objective was to describe the malaria situation in an urban environment during a period of military crisis. Data were gathered from personal interviews with heads of households and direct observations. Analysis of our results has made it possible to assess the various sources of mosquito proliferation, especially anopheles malaria vectors. The presence of anopheles is associated with two factors: Kennedy's natural environment; and the deterioration of the surroundings caused by war. Indeed, the principal breeding sites encountered in Kennedy are mainly comprised of vegetable and rice plots in the low land; puddles of water in the cracks resulting from damaged roads; and ruined or abandoned dwellings. The wide array of anopheles breeding sites and the deterioration of the environment are all factors which increase the risk of malaria transmission in Kennedy, where most inhabitants do not protect themselves against mosquito bites.

Keywords: Risk, malaria, urban, crisis, Bouaké, Ivory Cost

Introduction

Malaria is certainly not a new illness but it still remains the most widespread and deadly parasitic disease in tropical regions. It kills more than

one million people worldwide every year (Oms, 2005). The disease is most intensely prevalent in sub-saharan africa. In those regions, all children who reach the age of one will have experienced at least one attack of malaria (Oms, 2005). The impact of malaria is as serious on the populations' health as it is on their economy (Nosten, 2005): decrease in productivity and income of populations due to work absenteeism;poor yield; and the high cost of treatments. In spite of efforts undertaken by national malaria control programmes, incidence of this disease still constitutes a threat in many countries (Oms, 2008).

In ivory coast, malaria is transmitted on a perennial basis all year round, with seasonal upsurges (Dossou-Yovo *et al.*, 1998b; Nzeyimana *et al.*, 2002 ; Adja *et al.*, 2006). It is responsible for 10% of all deaths and comprises the principal cause of morbidity and death in regional paediatric wards (Pnlp, 2005). In 2006, seven million cases of malaria were recorded (Oms, 2008).

The persistence of some tropical diseases is encouraged by numerous environmental, climatic and anthropogenic factors, such as deforestation, creation of water reservoirs for irrigated crops, and war. The latter represents one of the greatest causes of the spread of disease (Oms, 2003). Armed conflict does indeed have a significant impact on the environment (anonyme, 2008). Military action destroys the natural habitat directly or indirectly, leaving behind a new landscape. Transformation of the original environment provides new conditions which can be either favourable or unfavourable for the development of disease vectors and parasites. In the case of malaria, disruption of the natural habitat is a major factor, which has an effect upon the establishment of the vectors' larval breeding sites. This change in the environment may thus cause the re-infestation of areas previously cleared of mosquitoes (Anonyme, 2008b) or the proliferation of vectors in areas which have already been colonised (Koudou *et al.*, 2007). Such spread of vectors may also be accompanied by disease transmission. War is also an obstacle to the implementation and maintenance of malaria-control initiatives due to the fact that virtually all medical facilities are non-operational. Only 17% of medical facilities were operational in the central, northern and western areas of ivory coast during the war (Betsi *et al.*, 2007).

Hence, after the five years of conflict this country has undergone, we now look into the malaria situation in those formerly war-torn areas. Following ivory coast's politico-military crisis, we should take stock of the malaria situation in those formerly besieged areas to allow for the implementation of appropriate control measures. It is against that background that this study was conducted in the town of Bouaké, specifically in the Kennedy district, in order to identify the risk factors of malaria transmission following the socio-political crisis.

Methods

Study site

Kennedy is located on the outskirts of the town of Bouaké. It covers an area of 3.997 kms² and is decidedly different from most of the town's districts because of its sumptuous villas and the inhabitants' high standard of living. Kennedy's population, as identified in 1998, numbered 5,085 inhabitants; that is, a density of approximately 1272 inhabitants per square kilometre (ins, 1998). Before the armed crisis, most of the heads of households in this district were senior executives, shopkeepers and industrialists. Over the course of our research, we subdivided Kennedy into two sub-districts: modern Kennedy (the residential area), and Kennedy village (an area of precarious housing comprised of the village of Koffikro).

The research took place between April and June, 2008. It involved determining Kennedy's socio-demographic and health characteristics. Before starting activities, we were careful to inform the new forces' administrative authorities from whom we acquired a work permit. Two teams of two people worked in the two areas (modern Kennedy and Kennedy village). French, Dyula and Baoulé were used as languages of communication.

The information gathered was recorded on data collection sheets. These data are both quantitative and qualitative. The following collection techniques were employed: personal interviews and direct observation.

A questionnaire sent to the heads of households allowed us to obtain data relating to the following: the number of people in households; the number of pregnant women; the number of children under the age of five; the professions of the heads of households; the commonest ailments; malaria protection measures; and the occupant's status.

Direct observation consists of ascertaining facts and studying Kennedy's housing and physical environment as they appeared during the war. Information relating to direct observation was written down on an observation sheet and pertains to the number of abandoned dwellings; the number of occupied dwellings; the condition of public infrastructure; and the composition of domestic animal species.

Larval breeding sites were identified by larval surveys carried out in April, 2008, in Kennedy at various water sources which might constitute mosquito larval breeding sites. The larvae were collected using the "dipping" method (service, 1989). The larvae were cultured at the insectarium and identified using the reference keys of Gillies and de Meillon (1968).

In this way, all areas likely to hold water, such as permanent rivers, paddy fields and vegetable plots, were listed, geo-referenced using GPS, and plotted on the map. Maps were made with Adobe Illustrator and MapInfo 6 software. Epi info software was used to analyse socio-demographic data. A 95% confidence interval was used for all analyses.

Results

Current profile of Kennedy's population

The socio-demographic study conducted in Kennedy in April, 2008, identified 1,785 inhabitants; that is, a density of 446.6 inhabitants / km². This population is divided as follows: 989 people in modern Kennedy and 796 in Kennedy village. Out of a total number of 355 households, 209 were identified within modern Kennedy and 146 in the village.

Pregnant women and children under five years of age who make up the social class most vulnerable to malaria account overall for 349 people in Kennedy. In total, 25 pregnant women and 324 children under the age of five were recorded in Kennedy, of whom 14 pregnant women and 184 children were in modern Kennedy and 11 pregnant women and 140 children in Kennedy village.

In a sample of 290 heads of household interviewed in Kennedy, caretakers, commonly called security guards, make up the largest proportion (32.1%) ahead of people doing various self-employed jobs (27.6%). Percentages of international civil servants and soldiers lie respectively at 4.5 and 2.8%.

Out of 187 households in modern Kennedy, 89, that is, 47.6% of heads of households, are caretakers. There is a significantly higher proportion of caretakers in this area than in Kennedy village ($\chi^2 = 58.25$; $p = 0.000001$). People doing various self-employed jobs, soldiers and international civil servants account for 19.3, 4.3 and 7% of workers respectively.

However, in Kennedy village, the majority of heads of households, that is, 42.7%, do various self-employed jobs. Around 7 and 11% of them are housewives and farmers respectively (table 1). There is a small proportion of caretakers in the village, accounting for only 3.9% of households. Unlike modern Kennedy, international civil servants and soldiers are completely absent.

Occupancy levels of dwellings and the health situation in Kennedy.

Occupancy levels of dwellings and public buildings

A total of 471 dwellings were recorded in Kennedy, of which 293 are in the modern district and 178 in the village. Of all these dwellings, 25.1% are abandoned, 26.9% are exclusively under surveillance, 15.7% are occupied by tenants and 32.3% by owners. We may infer that 52% of dwellings are unoccupied by inhabitants.

In modern Kennedy, 293 dwellings were recorded and, in contrast to the general trend, there were significantly higher percentages of abandoned houses and those being guarded by caretakers; that is, 73%. Very few houses are truly occupied, that is, 27%. This trend, which was observed in the modern

neighbourhood, is reversed in Kennedy village where most houses (64%) are occupied by their owners, whilst 18.6% of these houses are put up for rent. We may infer that 82.6% of dwellings in Kennedy village are actually occupied.

The health status of the population

Presumption of malaria within the population

Various illnesses were mentioned by Kennedy's inhabitants: malaria, fatigue, dermatosis, cephalgia (headache), furunculosis, gastroenteritis, gastric ulcers, lumbago and arthralgia. According to 74.3% of households, malaria is the primary cause of morbidity within their family. Fatigue, lumbago and arthralgia were mentioned in 7% of households. The other diseases were mentioned by very few households in Kennedy. Their proportion barely exceeds 6%. There is a high presumption of malaria in modern Kennedy as in Kennedy village, with respective rates of 76.6% and 71%.

Preventive measures used against mosquito bites

The following protective measures are used against mosquito bites in Kennedy: spray cans, smoke coils, basic mosquito nets, treated mosquito nets and screens at doors and windows. In a sample of 244 households taken from the entire district, 61.5% live without any protective measures against mosquito bites. Likewise, out of 153 households in the modern district and 91 households in Kennedy village, 66.6% and 52.8% respectively, go without protection against mosquito bites (table 2).

Across the whole Kennedy neighbourhood, only 7.8% of households owned a treated mosquito net.

The proportion of unprotected, vulnerable populations

In Kennedy, most pregnant women (66.7%) go without any protection against mosquito bites. This rate is just as high in the modern district as in the village; that is, 69.2 and 63.6% respectively. In Kennedy, none of the pregnant women own an insecticide-treated mosquito net (figure 1). In the village, only 8.3% sleep under a basic mosquito net.

Likewise, most children under the age of five, that is, 63.3%, go without any protection against mosquitoes. The same applies to modern Kennedy (69.1%) and Kennedy village (55.2%). Very few children (9.3%) sleep under an insecticide-treated mosquito net (figure 2). This trend may also be observed in Kennedy village (17.6%) and is more marked in modern Kennedy (3.4%).

Risks associated with the environment

Cracks in Kennedy's streets together with abandoned swimming pools within residences comprise the principal temporary sources of water. They

are fed by rainwater. These water sources lie for the most part along the roadside.

The low land which has been turned into farming allotments and a stream are permanent water sources. Various types of farmland are to be found alongside these water sources: vegetable plots, paddy and maize fields. In these areas, there is standing water, particularly in small ditches and footprints. There is standing water in paddies when the rice is at the “heading” stage.

Larval breeding sites and their composition.

After carrying out larvae surveys at 29 water sources, we identified 13 breeding sites containing mosquito larvae.

Anopheles gambiae larvae were found in puddles of water at the roadside, in vegetable plots and rice-growing areas in the low land. *Culex* larvae were gathered in vegetable plots and swimming pools. No *Culex* larvae were found in the roadside puddles.

Discussion

The decrease in the number of inhabitants observed shows that populations left the region in the aftermath of the war; hence there is a significant number of abandoned houses. The higher proportion of these dwellings is in modern Kennedy. In fact, this area was inhabited by senior civil servants, the majority of whom were expatriates. They left the town in the early days of the crisis. The tentative redeployment of local government and unstable security situation in formerly rebel-controlled areas may be hindering their return. However, in Kennedy village, the inhabitants, who are mainly comprised of natives, have stayed in their dwellings.

The abandonment of these sites by the population has caused environmental deterioration. Hence, there is the presence of many temporary water sources (cracks, puddles) favourable to the larval development of certain mosquitoes, including *an. Gambiae*, which is the principal malaria vector in the Ivory Coast. As a result, there is a high malaria transmission risk in this neighbourhood, where most inhabitants do not use any protective measure against mosquito bites. Around 67% of pregnant women and 64% of children under five years of age are faced with malaria transmission risks. The meagre incomes of heads of households might be the reason for the low rate of use of preventive measures. Indeed, the populations' poverty has been identified as an impediment to the implementation of actions to combat and treat malaria (Oms, 2005). Even though Kennedy's inhabitants consider malaria to be the leading cause of illness, they can nevertheless not prevent the disease due to their limited resources.

This study has shown the existence of *anopheles* larvae right in the middle of the town of Kennedy. This confirms results from previous studies by Dossou-Yovo in 2000. The large number of breeding sites found in this district could be responsible for the larvae's presence and indicates good adaptability of the potential malaria vector in the Kennedy district. Breeding sites were for the most part comprised of small bodies of aerated water; within footprints in the low land; and puddles. These are conducive to larval development of *an. Gambiae*.

The fact that inhabitants have left this district situated on the outskirts of town has fostered the settlement of breeding sites which are favourable to mosquito development. Surface water settles; it is stable and less polluted, providing the ideal environment for anopheline breeding site. Likewise, dwellings have been overrun with weeds which provide resting sites for adult mosquitoes. The reluctance of inhabitants to return and the use of areas for agricultural purposes have increasingly transformed the district into a rural type of environment.

Conclusion

This research has allowed an assessment of the risks of malaria transmission at a time of political and military crisis in Kennedy, an urban district of Bouaké. In-depth analysis of the results demonstrates that the armed crisis has changed what used to be a highly urbanised environment into a virtually rural area. Kennedy's environment during the crisis provided conditions which are conducive to the proliferation of *anopheles* larvae, of which the *an. Gambiae* species is the principal malaria vector.

The inhabitants' economic status has become extremely low. Practically all heads of households earn a meagre income as they only do various odd jobs. So, in spite of the high incidence of presumption of malaria, very few people manage to protect themselves against mosquito bites. Numerous children under the age of five and pregnant women, who together make up the population most vulnerable to this parasitosis, are faced with a very high risk of disease transmission. Kennedy's inhabitants are thus exposed to huge risks of morbidity and mortality from malaria.

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Table 1 : description of the occupations of heads of the household

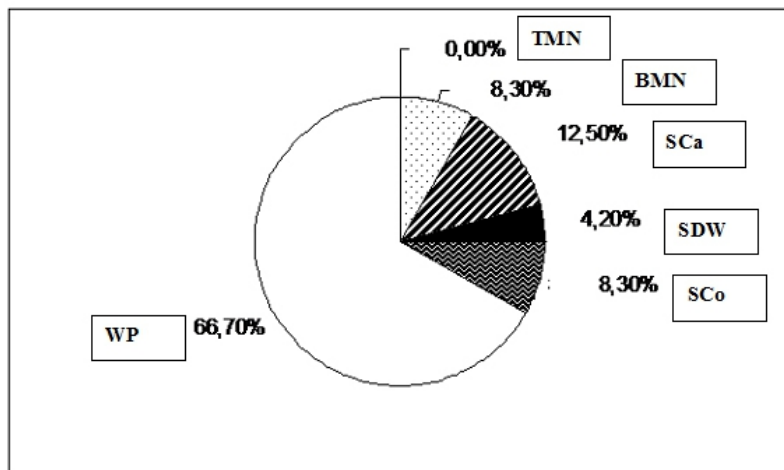
Occupations of household heads	Modern kennedy		Kennedy village		Kennedy	
	N	%	N	%	N	%
International civil servant	13	7	0	0	13	4,5
Soldiers	8	4,3	0	0	8	2,8
Self-employed jobs	36	19,3	44	42,7	80	27,6
Farmers	5	2,6	11	10,7	16	5,5
Security guards	89	47,6	4	3,9	93	32,1
Housewife	5	2,6	7	6,8	12	4,1
Others	31	16,6	37	35,9	68	23,4
Total	187	100	103	100	290	100

n : number of household heads

Table 2 : the protective measures are used against mosquito bites in kennedy

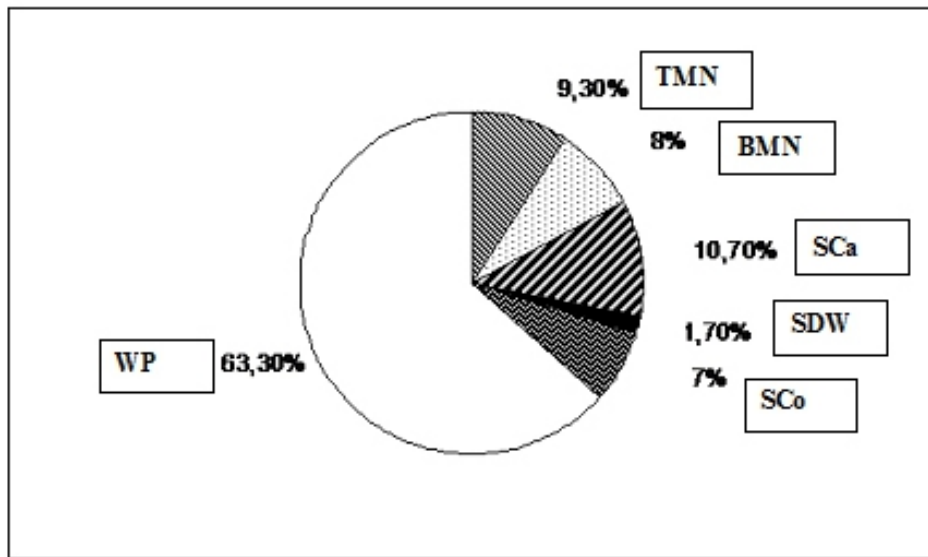
Preventive measures	Modern kennedy		Kennedy village		Kennedy	
	N	%	N	%	N	%
Tmn	5	3,3	14	15,4	19	7,8
Bmn	15	9,8	6	6,6	21	8,6
Spray cans	23	15	9	9,9	32	13,1
Smoke coils	2	1,3	13	14,3	15	6,1
Dw	6	3,9	1	1,1	7	2,9
Wp	102	66,7	48	52,7	150	61,5
Total	153	100	91	100	244	100

N :number of households; tmn :treated mosquito nets and; wp :without protection, dw :screens at doors and windows; sc : spray cans;bmn :basic mosquito nets



WP : Without protection; TMN : Treated mosquito nets ; BMN : Basic mosquito nets ; SCa : spray cans; SDW : screens at doors and windows; S Co. : Smoke coils

Figure 1 : Pregnant women and the preventive measures against mosquitoes.



WP : Without protection; TMN : Treated mosquito nets ; BMN : Basic mosquito nets ;
SCa : spray cans; SDW : screens at doors and windows; S Co. : Smoke coils
Figure 2 : Children under the age of five and the preventive measures against mosquitoes.