EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

MALARIA SUSCEPTIBILITY AMONG INDIGENOUS BAKA PYGMIES AND BANTU IN THE UPPER NYONG DIVISION, CAMEROON

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ABSTRACT

Promiscuity and extreme poverty may have led Baka pygmies to experience higher mortality rate due to malaria parasite than their Bantus neighbors. The aim of this study was to assess and compare the malaria prevalence among Baka pygmies, semi nomadic autochthones of the Congo Basin forest and their Bantus neighbors, sedentary of the Upper Nyong Division, East Cameroon. Blood was collected by venous swab and analyzed through thick blood smear. For each participant, gender, age, level of education, ethnic group, matrimonial status, occupation, house building materials and the used of ITN (insecticide treated net) were recorded. Data were analyzed with SPSS 22.0 and chi-square test at 95% served to compare proportion. *P. falciparum* was the only malaria parasite found. No significant difference was found between the malaria prevalence in Bantu and in Baka. Bantu females were more infected (49.6%) while in Baka, the prevalence was higher in males (55%). Infants of less than 2 years were more infected in Baka pygmies (60.9%) while Bantu teenagers were the most infected (50.3%). Participants who had never attended school were the most infected (58.9%). Single participants were significantly more infected (55 %) than married one. Baka house workers were more infected while in Bantu, traders were the most prevalent (64.5%). People living inside plank houses were more infected than others (50%). People sleeping under ITN were globally the most infected (47.8%). The malaria prevalence was globally more influenced by gender, age and the level of education and not by ethnic differences.

KEYWORDS: Malaria, Prevalence, Ethnicity, Baka, Bantu, Cameroon.

INTRODUCTION

Malaria is a major protozoan disease affecting human populations. Despite the 66% reduction in mortality between 2000 and 2015, malaria remains a major global public health problem.[1,2] Although it prevalence is gradually declining in many parts of Africa, its spatial and temporal variability presents new challenges for control programs.[3] In Sub-Saharan countries, infection is mainly determined by highly competent mosquito vectors, widespread poverty, limited infrastructure, and overburdened health systems.[4] Such a situation leads to the death of a child below five years every 2 minutes in Africa.[5] In Cameroon, malaria is the first cause of mortality in children under five years old (41%) and it is responsible for 18 % of adult mortality.[6] According to[7], malaria infection depends on how man's own habits expose him to the vector agents.

The forests of the Congo Basin are our planet's second-largest forest zone and constitute one of its richest areas in terms of biodiversity.[8] It's inhabited by the largest and most diverse group of African Pygmies, which are among the most active hunter-gatherers that still remain in the world.[9] They comprise at least 15 different ethno linguistic groups including the Bambuti, Asua, Efe, Bagyéli-Bakola, Batwa, Aka, Babongo and Baka, found in the Democratic Republic of Congo, Rwanda, Gabon, Congo and Cameroon.[9,10]

In Cameroon, indigenous Baka are a semi-nomadic population who had always lived on hunting, gathering, fishing and picking of forest products.[9] For many decades, the Cameroonian government has substantially increased the number of tropical forest parks and reserves in the Congo Basin and this has led to the displacement of these forest people who try to settle around Bantu villages. But there, they are victim of marginalization and exploitation from their Bantu neighbors.[10] Humanitarian groups like FairMaid have tried to identify the needs of Pygmies and have initiated a range of interventions to decrease their marginalization, by allowing them to have access to

education, law courts, jobs, forest resources and health. However, according to[11], they suffer from malnutrition, diarrhea, gastritis, typhoid, intestinal infection and malaria more than their Bantu neighbors; but to our knowledge, data in Cameroon concerning their health situation remains scanty.

The aim of this study was to assess and compare the prevalence of malaria infection among indigenous Baka pygmies and that of Bantu living in the same rural area of the Upper Nyong Division of Cameroon.

MATERIALS AND METHODS
Study period
A cross-sectional study was administrated in 08 villages covered by the Nkouak integrated health center, from May 2018 to April 2019.

Study area and population
Nkouak health sector is situated between Abong Mbang (24 km) and Mindourou (29 km), in the Upper Nyong Division, East Region of Cameroon. It covers two health facilities including Nkouak integrated health center where the study was conducted. The center serves 4315 residents distributed among 8 small villages. Between the 8 villages some are occupied mainly by Bantu (like Nkouak, Nongbwala, Djouyaya, Etsiek, Kagnol) while others are occupied mainly by Baka Pygmies (Mballam II, cyrie, Mayos). The study area is situated at latitude 3°N and longitude 13°E and it covers an area of about 20 km.[12]

Nkouak health sector is situated in the Abong Mbang health District (Rural municipal council of Mindourou). The council is covered by several permanent streams like Dja and Nyong Rivers which surround the study area. The climate of the council is a warm and cold classic equatorial climate characterized by two rainy seasons (from March to June and from August to November) and two dry seasons (from June to August and from November to March).[13] The annual average temperature varies between 23°C and 28°C, with a high atmospheric humidity all year round.[14] The average rainfall varied between 1550 and 1700 mm/year. The vegetation is characterized by an evergreen transitional forest and by a semi-deciduous dense and moist forest.[13] Figure 1 shows the study area.
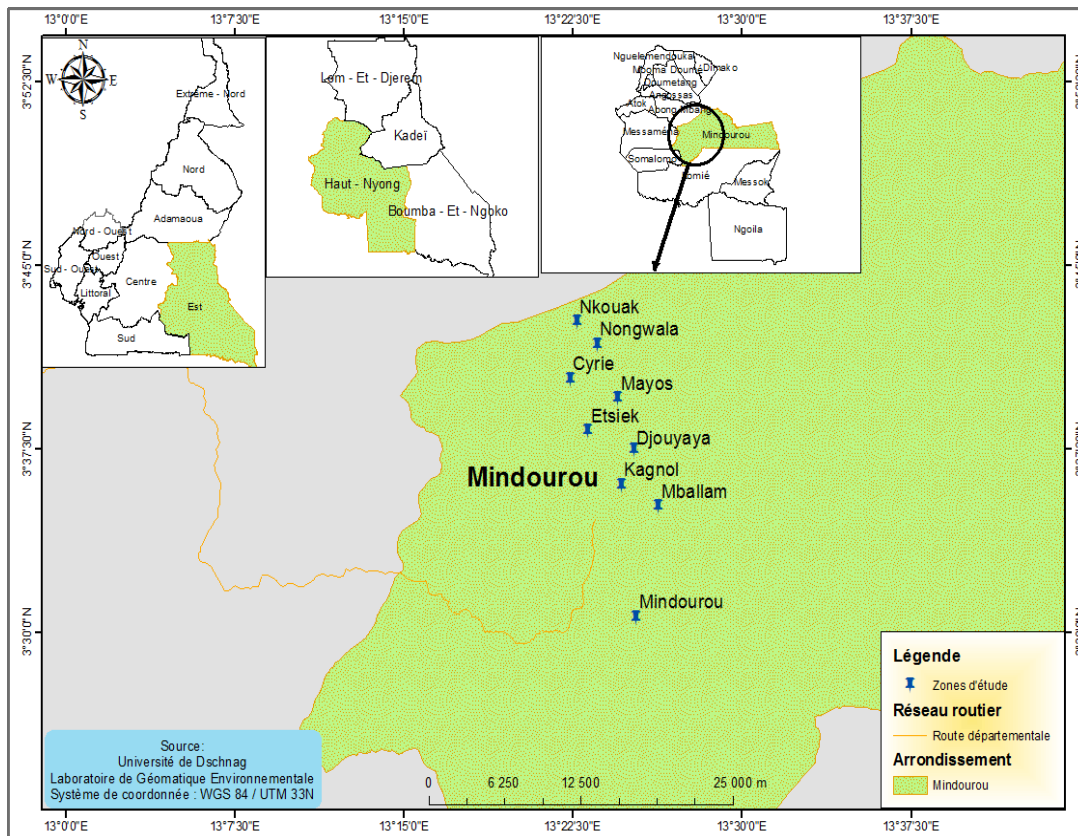
Figure I: Nkouak health sector.[15]

Nkouak is mainly a farming area and most inhabitants are farmers. Some of the people are employed by Forest Company like PALLISCO, FIPCAM, DINO et Fils Company. Malaria is the main mosquito-borne disease in that locality and as such a public health problem of primary importance. Some of the diseases common in Nkouak locality are HIV/AIDS, intestinal infections, filarial infestations, cough, meningitis, respiratory infection, diabetes, anemia, malnutrition, typhoid fever, yaws and skin infections. Nkouak is predominantly a Christian community.[14]

Sampling technique

The survey took place during routine child vaccination trips. The respondents' consent was sought and gained after explaining the aim of the study. Some information was recorded from the participants like the gender, the age, the level of education, their ethnic group, the matrimonial status, house building material was observed, main occupation and the utilization of ITN or not.

According to age, previous studies showed that people in different age groups have different levels of immunity to malaria. The modified age groups adopted by[1,2] was used in this study as follow: people from 0 to 18 months were considered as infants, from 19 months to 5 years as children, from 6 to 15 years as teenagers, from 16 to 50 years as adults and people of 51 years and above were known as elders.

Those who could not read, write or understand French language were communicated to in the local language and the participant's responses were recorded accordingly. The discussion with participants took place in the Council house of each village, where blood collection took place. Blood was collected using EDTA test tubes either by finger prick or by venous swab according to the participant's desire.

Microscopic analysis

Blood samples collected were analyzed in the laboratory of the District Hospital of Abong Mbang. Thick and thin blood smear were prepared according to the technique used by.[16] The Giemsa-stained smears were examined using 100X (oil immersion) objective of a light microscope (Olympus trade brand). Slides were reported negative for parasites only after observing at least 50 fields.[17] The prevalence was defined as follows:

$$Prevalence = \frac{number\ of\ positive\ sample}{total\ number\ of\ sample} x100$$

Ethical considerations

The study was conducted under an ethical clearance number 2018/05/1036/CE/ CNERSH/SP delivered by the Cameroon National Ethical Committee for Research on Human Health. All volunteers participating in human landing catches signed a written informed consent form indicating their willingness to take part in the study. Children under five years old received free malaria prophylaxis.

Data analysis

Data was analyzed with the Statistical Package for Social Sciences (SPSS), version 22.0. Proportions were compared using the chi-square test. The Significant level of all tests was set at 0.05.

RESULTS AND DISCUSSION
Results
Characteristics of the study population

The overall population of this study was 1032. Four hundred and one (38.86%) of which were Baka and 631 (61.14%) were Bantu. In Baka pygmies, 272 were females and 129 males while in Bantu people, we had 410 females and 221 males. This study population comprised children less than five year old, students, teachers, laborers, housewives, watchmen, farmers, hunters, drivers, dressmakers, electricians and traders. Table 1 shows the characteristics of the study population.

Table 1: Characteristics of the study population.

Parameters	Variables	Baka	Bantu	Total
Gender	Males	129	222	351
	Females	272	409	681
Age[18]	0-18 months	23	49	72
	19 months - 5 years	97	156	253
	6-15 years	83	151	234
	16-50 years	189	253	442
	51 years and above	9	22	31
Levels of education	No school	129	192	321
	Primary education	258	278	536
	Secondary education	14	160	174
	Higher education	0	1	1
Professions	Farmers	201	165	366
	Students	64	182	246
	Civil servants (teachers, nurses, municipal advisor)	1	9	10
	House workers (housewives, children under five, dress makers, painters)	133	243	376
	Forest operators (watchmen, hunters)	2	19	21
	Traders	0	13	13
Matrimonial Status	Married	192	200	392
	Single	209	431	640
TOTAL		401	631	1032

Table 1 shows that of 31 elders recorded, only 9 were Baka pygmies. No Baka and only one Bantu of higher education level were recorded in the study area. Of the 10 civil servants recorded in the study area, only one was of Baka ethnic group. Forest operators were mainly represented among Bantu (19 persons) than Baka people (2 persons). On the thirteen traders recorded, no Baka Pygmies was represented.

The overall malaria prevalence in the study population
Of the 1032 blood samples examined, 480 were positive to malaria test giving the prevalence of 46.5 %.

Malaria prevalence according to ethnic groups
This study revealed a global malaria prevalence of 46.5% with no significant difference (p>0. 05) between indigenous Baka (46.6 %) and Bantu (46.4 %). Malaria was therefore not affected by ethnic groups.

Malaria prevalence according to age groups
The variation of malaria prevalence with ethnic groups and age of the individual is presented in the table 2.

Table 2: Prevalence (%) of malaria infection according to age and ethnic group.

Ethnic groups	Age groups				
	0-18 months	2-5 years	6-15 years	16-50 years	51 years and above
Baka	60.9	57.7	51.8	38.6	11.1
Bantu	49.0	48.1	50.3	43.9	31.8
Average	52.8	51.8	50.9	41.6	25.8

In general, it was found that malaria prevalence decreased with age (p=0.004). Infants were the most infected (52.8 %) and elders the least infected (25.8 %). This is particularly the case in Baka pygmies where infants were significantly more infected (p<0.05) than others age groups. Fluctuating malaria prevalence was observed in Bantu and the range of 16 to 50 years old individuals was the most infected. In all cases, elders were less infected by malaria parasite than all others groups.

Malaria prevalence according to the level of education
Table 3 shows how prevalence varies with the level of education in the two ethnic groups.

Table 3: Variation of malaria Prevalence (%) according to the level of education between the two ethnic groups.

Ethnic groups	Levels of education			
	No school	Primary education	Secondary education	Higher education
Baka	58,9	41,5	28,6	0,0
Bantu	48,4	48,2	41,3	0,0
Average	45,0	52,6	40,2	0,0

It comes out from this table that people who attended only primary education were significantly (p=0,029) more infected (52, 6%) than those of other levels of education. In Bantu people, no statistical difference was recorded between the malaria prevalence of people who had never gone to school (48, 4%) and that of those who attended primary school (48,2%). In contrast, in Baka pygmies a significant difference (p=0,002) was noticed. The prevalence of malaria was higher in those who never went to school (58, 9%), than those who received an education (41, 5 % and 28, 6 % respectively for primary and secondary education). People who reached higher education were the least infected. So, the level of education clearly affects the prevalence of malaria infection.

Malaria prevalence according to Gender and matrimonial status
Table 4 shows how malaria prevalence varies with the host sex and matrimonial status between the two ethnic groups.

Table 4: Variation of malaria prevalence (%) by host sex and matrimonial status between the two ethnic groups.

Ethnic groups	Gender		Matrimonial status	
	Males	Females	married	single
Baka	55.0	42.6	37.5	55.0
Bantu	40.5	49.6	43.0	48.0
Average	45.9	46.8	40.3	50.3

In general, prevalences were similar in females (46.8%) and males (45.9%). Bantu females were significantly (p=0.029) more infected by malaria parasite than males (49.6% and 40.5% respectively). In contrast, in Baka pygmies, females were less infected (42.6%) than males (55%). The same Table shows that single are more infected by malaria parasite (50.3%) than those who are married (40.3%) with a significant difference (p=0.002), irrespective to ethnic group.

Malaria prevalence according to occupation
The distribution of malaria infection among Bantu and Baka Pygmies of different occupations is presented in table 5.

Table 5: Prevalence (%) of malaria infection by type of occupation in Bantu and Baka pygmies.

Ethnic groups	Occupations					
	famers	students	civil servants	house workers	forest workers	traders
Baka	38.3	54.7	0.0	55.6	50.0	0.0
Bantu	48.5	47.8	44.4	45.3	21.1	61.5
Average	42.9	49.6	40.0	48.9	23.8	61.5

Malaria was affected by the type of occupation. In general, traders were the most infected (61, 5%) with malaria although in Baka pygmies, the highest malaria prevalence was observed in house workers (55, 6%).

Malaria prevalence according to the house building materials and mosquito net utilization
The distribution of malaria prevalence according to the house building materials and mosquito net utilization is presented in Table 6.

Table 6: Prevalence (%) of malaria infection according to house building materials and the used of mosquito net.

Ethnic groups	House building materials			Mosquito net usage	
	Mud houses	brick houses	plank houses	Yes	No
Baka	46.8	0.0	0.0	51.3	44.7
Bantu	46.5	40.0	50.0	46.3	46.6
Average	46.6	33.3	50.0	47.8	45.7

Table 6 shows that houses constructed with plank seem to expose people to malaria infection (50%) more than houses made of others materials. The same table shows that prevalence was not affected by mosquito net usage.

DISCUSSION
The overall malaria prevalence recorded in the study area was 46, 5%. According to[19], the occurrence of malaria in the forest area is significantly higher than in the non forest area. Forest ecosystems are well known to support transmission of malaria, because there, vectors tend to bite during daytime and outdoors.[20,21] They provide conditions such as vegetation cover which assures shade even during the hottest hours, temperature, rainfall and humidity which protects mosquitoes from estivation and death; importantly, in forest, there is an absence of infrastructure and human vector-control measures, all these conditions favor the survival and distribution of malaria vectors.[20,22] These can justify the higher malaria prevalence recorded in this study area (46, 5 %).

This prevalence was higher than what has been reported by[23] in Bolifamba, a southern Cameroonian rain forest zone (33, 7%) and less than the result of[24] obtained in Bangladesh, where a prevalence of 47, 7% was recorded in an area of third tertile of forest cover. Though forest harbor favorable condition to malaria transmission,[25] showed that deforestation increases malaria incidence, and the strength of these relationships depends on the stage of land use transformation. In their research, they suggest that10% increase in deforestation leads to a 3.3% increase in malaria incidence. In the same way,[24]

showed that malaria prevalence in forest ecosystems depend on the degree of forest degradation (47.7% prevalence for third tertile of forest cover and 17.6% for second tertile of forest cover). This can explain why different prevalence can be observed in different forest ecosystems.

Apart from characteristics described above, forests also harbor tribes with distinct genetic traits, socio-cultural beliefs and practices that greatly influence malaria transmission dynamics.[20] In this study, malaria prevalence was compared between two forest tribes, Baka indigenous pygmies and their Bantu neighbors. It came out that Baka pygmies recorded approximately the same malaria prevalence with their Bantu neighbors (46, 6 % and 46, 4 % respectively). In contrast,[26] in their works showed that malaria prevalence in Batwa indigenous pygmies of Uganda was higher than in non Batwa (9.35 versus 4.45 %, respectively). According to[24], the malaria transmission dynamic often depend on the distance of people from the forest, because people living around the densest forest (upper third tertile) are at a significantly higher risk of being infected compared to the first and second tertiles. Moreover,[27] reported that ethnicity may influence norms and attitudes resulting in disparate immunization rates. For[28], this equilibrium in the malaria prevalence between the two forest tribes provides an indication that they share the same life style (semi nomadic life between the forest and the village) and the same geographical and social constraints.[29;13]

In general, malaria prevalence was higher in women than in men, even though in Baka pygmies, the reverse was observed. This can be explained by norm and attitude associated to each ethnic group. Although traditionally women are at lower risk of infection than men because they cover their bodies more than men[30],[31] argued that the higher proportion of infected women could probably be due to the fact that they spend more time outdoors at dusk and dawn than men and as such are more exposed to mosquito bites.

Malaria prevalence was age dependent in this study. Elders were the least infected groups. Generally, immunity to malaria builds up with increasing age, given the continuous exposure to the disease agent. Immunity occurs naturally in response to repeated infection, especially among adults in areas of moderate or intense transmission conditions.[32]

Malaria prevalence was higher in people who attended only primary school. The lowest prevalence was observed in those who reached higher education.[33] found that women with lower levels of education were more likely to have fever than more educated women. Actually, those who went to university are generally believed to be in contact with media, publicity and sensitization about malaria and are more careful about their environment and about the use of their mosquito net and medication.

The higher infection rate in single participants (50, 3%) than in married ones (40, 3%) may be due to the fact that, married persons tend to take care of their family, particularly of their children. By doing so, they also take care of themselves by sleeping under mosquito net, by taking malaria traditional drugs that they prepare for their children.

Globally, malaria prevalence was higher in traders. But inside Baka population, the most infected participants were house workers (55.6%). Certain occupations place individuals at a greater risk for malaria infection than others. For instance,[34] in their research found that sailors and deep-sea fishermen were more infected by malaria parasite than monks and professionals like physicians, lawyers, pilots, engineers and geodesists. Moreover, traders and house workers are people who get up very early in the morning to go about one's work, when malaria vectors are still in activity. By so doing, they expose themselves to mosquito bites more than others. Moreover, traders spend more of their time along the road, where they have no protection equipment against mosquito bites.

Malaria prevalence also varies according to the housing material because greater exposure to the outdoors (lack of windows or screens, for example), may increase contact between an individual and the mosquito vector.[33] It was found that Bantu people living in plank houses were more infected than those living in house constructed with other materials (Mud houses and brick houses). This result is opposite to the hypothesis that the use of mud for wall construction is associated with the occurrence of malaria.[28]

According to WHO, they are two principal ways to fight against malaria vectors, among which the used of insecticide treated net (ITN).[35] But in this study, the use of mosquito nets did not seem to affect malaria prevalence. In fact, among those who were positive to malaria test, the majority was those who slept under a mosquito net. This confirms what has been said by[35] who argued that people lay in close contact with the mosquito net such that they can be bitten from outside. Moreover, in forest ecosystems, vectors tend to bite during daytime and outdoors, thus reducing the effectiveness of insecticide-treated bed nets.[20,21]

CONCLUSION
P. falciparum was the only malaria parasite found in the study area. The prevalence of malaria infection among Baka and Bantu does not differ significantly. Nevertheless, the prevalence was globally influenced mainly by gender, age and level of education, and not by ethnic group as hypothesized in the beginning. This study confirm the fact that children under five needs particular care against malaria parasites and a good sensitization about the disease must be helpful in the process of malaria eradication.

ACKNOWLEDGEMENTS

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