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Investigating risk factors associated with the persistence of malaria in the Obang valley, North West Region, Cameroon

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Malaria interventions - vector control using long-lasting insecticidal nets (LLINs) or indoor residual spraying, chemoprevention and case management including diagnosis and treatment of infections - are highly effective and affordable. These interventions have led to a significant reduction in malaria prevalence, and a marked decline in morbidity and mortality associated. Despite these increasing control efforts, this parasitic disease is still persisting in most African countries. The aim of this study was to investigate the risk factors associated with malaria infection in the Obang Valley (North Western Cameroon) in order to identify potential bottlenecks in the malaria elimination procedure. A structured questionnaire was administered to a random sample of 100 individuals visiting the Mbakong Health Centre or attending the Obang Government High School. Association between malaria infection and individual household or environmental risk factors was investigated using logistic regression models. Malaria infection was not significantly associated with LLIN possession (p = 0.999) since 97% of interviewees received them free of charge. The age and habits (having each bed cover by a LLIN, time when doors and windows are closed or antimalarial medicine used) of study participants were however significantly associated with malaria infection (p < 0.033). These findings suggest that although the interventions recommended by the World Health Organization may help in reducing malaria prevalence and burden, it is of prime importance to also tackle associated risk factors which are mostly related to individual habits.

Key words: Malaria, risk factors, Obang Valley, Cameroon.

INTRODUCTION

Malaria remains a primer life-threatening disease and therefore a serious public health concern worldwide. In 2016, an estimated 3.2 billion people in 91 countries and territories were at risk of infection with *Plasmodium*.

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216 million cases of malaria occurred worldwide, with an estimated 445,000 deaths, the World Health Organization (WHO) African Region accounting for 91% of all malaria deaths (WHO, 2017a, 2018).

Malaria is an entirely preventable and curable mosquito-borne disease. Indeed, it is accepted that implementation of proven malaria control and prevention measures can reduce transmission within short to moderate timeframes nearly everywhere malaria occurs (WHO, 2014). In the framework of the 68th World Health Assembly held in 2015 (WHA68/2015/REC/1), the WHO developed the 2016–2030 Global Technical Strategy (GTS) to preserve progress achieved against malaria and reach global elimination of this deadly disease (WHO, 2017b). The GTS lays on three pillars: (i) ensure universal access to malaria prevention, diagnosis and treatment, (ii) accelerate efforts towards elimination and attainment of malaria-free status, and (iii) transform malaria surveillance into a core intervention (WHO, 2015a). As for pillar #1, the recommended interventions against malaria (vector control using insecticide-treated mosquito nets or indoor residual spraying, chemoprevention and case management including diagnosis and treatment of infections) are highly effective and affordable, and their wide-scale implementation has led to a significant reduction in malaria prevalence and a consequent decline in morbidity and mortality associated. Indeed, between 2000 and 2015, the rate of new malaria cases declined globally by an estimated 37%, and the global malaria death rate fell by 60%, with 6.2 million lives saved (WHO, 2015b).

Despite these increasing control efforts, the disease is still persisting in most African countries. Indeed, the overall rate of new cases of malaria has decreased over years, though the trends since 2014 have levelled off and even reversed in some regions. Malaria mortality rate is therefore following a similar pattern over years, with a stability observed in number of deaths (445,000 in 2016 vs 446,000 in 2015) (WHO, 2018). Thought these figures can result from improved diagnostic methods and close sensitization of populations, it is likely that the decrease in the morbidity and mortality associated with malaria is largely disproportional as regards to the efforts deployed to fight against this deadly disease. It was indeed reported that progress stalled and the critical 2020 milestones will not be reached (WHO, 2017a). It therefore appears of prime importance to investigate the potential specific reasons associated with the persistence of the disease and the stagnation in the number of deaths despite control efforts.

The aim of the present study was therefore to investigate the risk factors associated with malaria infection in the Obang Valley (North West Region, Cameroon) where the trends in the prevalence of malaria were reported to level off or reverse over seven years of follow-up (Ndong et al., 2014; Gangue et al., personal communication), in order to identify potential bottlenecks in the malaria elimination procedure.

MATERIALS AND METHODS

Study design and data collection

This study aimed at investigating the risk factors associated with the persistence of malaria in the Obang valley (North West Region, Cameroon). Individuals eligible to this survey were those visiting the Mbakong Health Centre or attending the Obang Government High School. This health facility and this school were chosen for representativeness purpose, since they are the most visited/attended by the vast majority of the population of the valley. Data were collected using a structured questionnaire, self-administered and returned back to investigators. A face-to-face interview was used for illiterate study participants. In addition to the self-reporting of malaria episodes (frequency, latest episode), questions included participants' socio-demographic data (gender, age, profession), knowledge, attitudes and practices with regards to malaria clinical manifestations and the strategies used to prevent or treat this parasitic disease, including possession, use and re-impregnation of long-lasting insecticidal nets (LLINs), as well as the habits of study participants with regards to farming near their houses, and the time at which they usually close doors and windows.

Description of the study area and population

This study was carried out in the Obang valley, located in the Mezam Division (North West Region, Cameroon). Similarly to the entire North West Region, the Obang valley is characterized by accidental relief made up of massifs and mountains. The valley is irrigated by the Mezam River and its tributaries, and it features seven small lakes and dormant volcanoes such as the Mount Oku. In the Obang valley, prevails the equatorial type climate organized into two seasons: (i) a short dry season running from November to March, and (ii) a long rainy season extending from March to November. The average annual rainfall is 2,400 mm, and the average annual temperature is 23°C (NIC-MINEPAT, 2013; Ndoh Mbue et al., 2016). This area was previously covered by a forested vegetation but the forests were progressively cleared for farmland and grazing, so that nowadays, only patches remain (Ndoh Mbue et al., 2016). Indeed, the soil of the Obang valley is very fertile thanks to the past volcanic activity in this area; as such, the main activity of the people of Obang valley is farming (rice farming, maize farming, cocoyam, cassava, beans), though fishing and sand extraction are also practiced. The population of the valley is made up of about 15,000 inhabitants belonging to seven ethnic groups (Obang, Mbakong, Buwi, Otang, Butang, Manta'a, Titashi) (Fon Nanoh II, personal communication).

Data analyses

A purpose-built Microsoft Office Excel datasheet was used for data entry of each questionnaire beforehand checked for completeness. Categorical variables (gender, occupation, possession, use of LLIN) were summarized using frequencies with 95 % confidence interval (CI) and compared using the Chi-square test. Continuous variables (age) were described using mean (standard deviation, SD) and/or median (interquartile range, IQR).

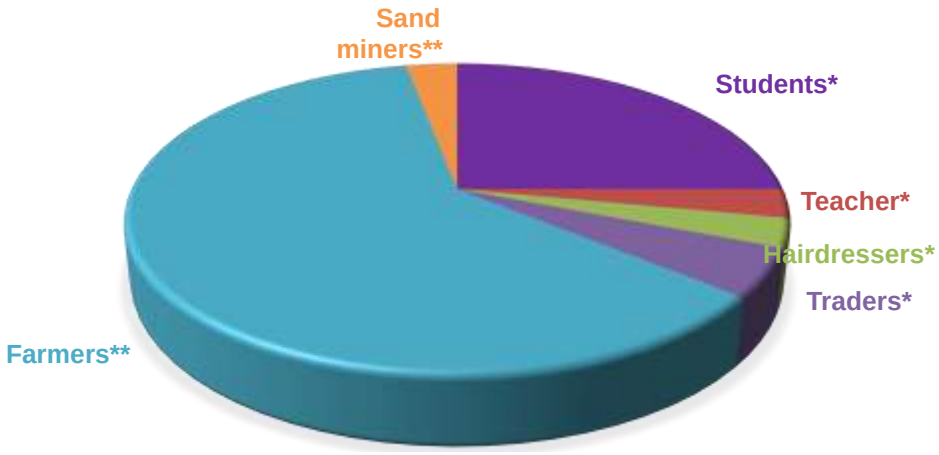

Figure 1. Occupation of study participant. * category #1; ** category #2.

Odds ratio (OR) with 95% CI generated using logistic regression models were used to describe the strength of association between the response variable or outcome (malaria frequency and latest episode) and independent variables (LLIN ownership, use, status as well as habits of the interviewees such as having farm around houses, time to close doors and windows, medecine taken against a suspected malaria case) before and after controlling for possible confounding variables. All statistical analyses was performed using *PASW Statistics* version 18 (SPSS Inc., Chicago, IL, USA); 95% CI was performed online using VassarStats computational website. Non-overlapping 95% CI or p-values ≤ 5% were considered as statistically significant.

Ethical consideration

The present study received approval of the Faculty of Science of the University of Bamenda. Administrative authorization was granted by the Mbakong District Medical Officer. Prior to the commencement of interviews, the objectives of the study were explained to all eligible individuals and informed verbal consents were obtained from those who agreed to participate. Each volunteer was then attributed an individual code to ensure the privacy and confidentiality of personal information as well as anonymous data analysis.

RESULTS

Socio-demographic characteristics

A total of 100 individuals, among whom 35.0% males, were interviewed in the framework of this study. Interviewees were aged 16 to 70 years old (Median = 27.0; IQR = 20.0-39.2). Most of these study participants were farmers (61.0%) and students (25.0%) (Figure 1).

Malaria experience and control approaches

Overall, 28.4% of the interviewees declared having suffered from malaria at least once within the year, whereas 71.6% presented with their last malaria episode more than one year ago. Table 1 summarizes the characteristics and habits of study participants with regards to malaria infection. As regards to the means of prevention of malaria, 97.0% of the study participants owned a LLIN, though a small proportion (5.2%) declared not using their LLINs. A significant difference (Chi-Square = 30.375; df = 1; $p < 0.0001$) was found between those regularly using their LLIN (77.9%) as compared to those using it from time to time (22.1%), the latter believing that it is uncomfortable to sleep under the net. A total of 82.5% of the participants declared that each bed in their house was cover by a net, though 20.6% of them acknowledged that their net was in a bad status, with holes. Also, 95.9% of bed net owners declared that they had never treated their mosquito nets, mainly because they had never heard about bed net reimpregnation with insecticides. Regarding the drug taken when there was a suspicion of malaria, the difference was not significant (Chi-Square = 0.471; df = 1; $p = 0.493$) between those declaring treating themselves with approved antimalarial drugs (55.9%) as compared to those taking decoctions (fever grass, pawpaw and guava leaves) or just antipyretics.

Interviewees' habits and potential risk factors associated with malaria

Regarding the habits of individuals interviewed, 81.0% of participants declared that their houses are surrounded by a farm or garden, and 69.0% of them declared closing their doors and windows before 6 pm. Univariate binary logistic regression showed that no significant association was found between malaria last episode and gender, occupation, LLIN possession, LLIN use (either regularly or not), or having a farm/garden around house ($p >$

Table 1. Characteristics and habits of study participants with regards to malaria infection

Characteristics	Number of respondents	Percentage (95% CI)
Farm/garden around house		
No	19	19 (12.5 – 27.8)
Yes	81	81 (72.2 – 87.5)
Time to close doors and windows		
Before 6 pm	31	31 (22.8 – 40.6)
After 6 pm	69	69 (59.4 – 77.2)
LLIN Ownership		
No	3	3 (1.0 – 8.5)
Yes	97	97 (91.5 – 99.0)
Number of year of LLIN possession*		
Less than 3 years	92	94.8 (88.5 – 97.8)
More than 3 years	5	5.2 (2.2 – 11.5)
Status of LLIN*		
Good	77	79.4 (70.3 – 86.2)
Bad with holes	20	20.6 (13.8 – 29.7)
Each bed covered by a LLIN*		
No	17	17.5 (11.2 – 26.3)
Yes	80	82.5 (73.7 – 88.8)
Bed net treatment*		
No	93	95.9 (89.9 – 98.4)
Yes	4	4.1 (1.6 – 10.1)
Use of LLIN*		
No	2	5.2 (2.2 – 11.5)
Yes	95	94.8 (88.5 – 97.8)
Regular use of LLIN**		
No	21	22.1 (14.9 – 31.4)
Yes	74	77.9 (68.6 – 85.1)

95% CI: 95% Confidence interval; LLIN: Long lasting insecticidal net; * only among those owning a LLIN; ** only among those using a LLIN

0.610). Malaria last episode was however significantly associated with the age of interviewees (OR = 1.045; 95% CI: 1.007-1.084; p = 0.020) (Figure 2), the time at which they usually close doors and windows (OR = 0.237; 95% CI: 0.076-0.739; p = 0.013), the fact to have each bed in the house cover by a LLIN (OR = 0.096; 95% CI: 0.022-0.423; p = 0.002) and the intervention (conventional antimalarial drugs vs decoctions) used when malaria was suspected (OR = 0.143; 95% CI: 0.024-0.852; p = 0.033). Also, the age of interviewees was negatively associated with regular used of LLINs (OR = 0.955; 95% CI: 0.925-0.986; p = 0.005).

DISCUSSION

This study was carried out in the Obang valley (North West Region, Cameroon) where the trends in malaria prevalence have decreased after LLIN distribution campaigns, but subsequently reversed two years later

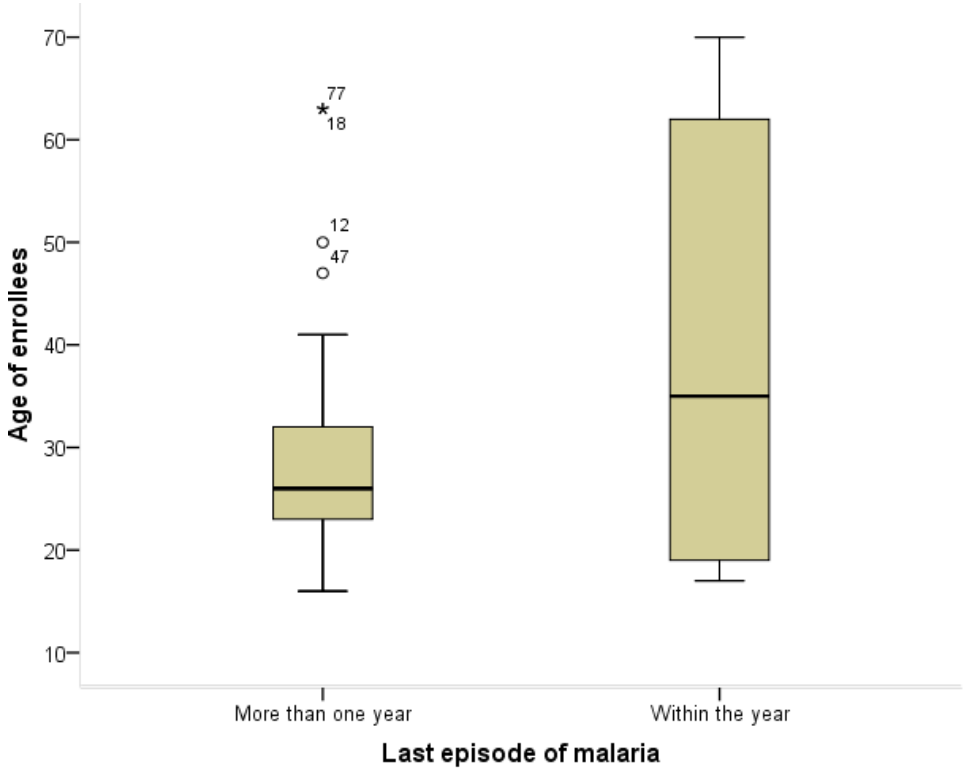

Figure 2. Age shift among individuals experiencing malaria.

(Ndong et al., 2014; Gangue et al., personal communication), in order to investigate the risk factors associated with malaria infection, and identify potential bottlenecks slowing the momentum towards malaria elimination.

The proportion of those who declared having experienced an episode of malaria within the year was 28.4%, similar to the prevalence over a period of seven years in this area (Ndong et al., 2014; Gangue et al., personal communication). This figure indicate that malaria is still highly endemic in the study area, and control measures might not be really effective since the prevalence of malaria has levelled off and even reversed in the study area as previously observed elsewhere (WHO, 2018).

Long-lasting insecticidal net (LLIN) is a core prevention tool widely used to fight against malaria, and it was shown that the universal coverage with LLINs has help in reducing the global malaria burden since 2000. Moreover, in a recent WHO-coordinated prospective international observational cohort study, it was demonstrated that LLINs still provide a significant level of protection against malaria, even where mosquitoes are resistant to pyrethroids, thus supporting the continuation of their use (Kleinschmidt et al., 2018). Indeed, almost all our study participants owned a mosquito net, and no significant association was obviously found between malaria infection and LLIN possession ($p = 0.999$). It was not surprising to find that almost all bed net users had never treated their mosquito nets since LLINs - insecticide-treated nets designed to remain effective for multiple years without retreatment - were massively distributed in Cameroon since 2011, with 88% total coverage (FIS, 2016), to comply with WHO recommendation in order to achieve and maintain universal coverage with LLINs. Importantly, LLIN covering each bed in a house appeared as a protective indicator against malaria infection. The question then remained as to whether those individuals receiving LLINs free of charge are using them, quest to jeopardize the efforts of the control programmes and stakeholders. In the framework of this study, only a small proportion of individuals interviewed (4.0%) indicated that they didn't use their bed nets for comfort reasons. Previous studies have reported the factors influencing the bed net use (Xu et al., 2014; Russell et al., 2015), the fact to think that bed nets present any disadvantage being significantly associated with decreased odds of net use.

A negative association was observed between the last episode of malaria and the time when doors and windows are closed, those experiencing malaria more frequently during the year surprisingly declared to close their doors and windows before 6 pm. Though this habit is not

enough as a preventive action against malaria, this observation might be explained by the fact that mosquitoes are able to bite when people are still outdoor. Indeed, a shift in mosquito biting to earlier hours of the evening - before individuals are indoors and protected by bed nets - was previously observed, and shown to compromise the efficacy of vector control in reducing malaria transmission (Thomsen et al., 2017). This behavioural resilience in mosquitoes highlight the necessity to target outdoor exposure to their bites, and thus more efficiently control and potentially eliminate malaria. The last episode of malaria was found to be positively associated with age of interviewees (OR = 1.045; 95% CI: 1.007-1.084; p = 0.020), indicating that older individuals experienced malaria more frequently than their younger counterparts. This might be explained by the fact an age-related increasing trends was observed among those declaring not regularly using their bed nets, suggesting that these older individuals might therefore be more exposed to mosquito bites and subsequently to malaria infection than younger ones, especially in a context where none of the interviewees was known to belong to a high risk group.

This study also revealed that the measures used to tackle malaria (or suspicion of infection) was significantly associated with the latest episode of the disease. Indeed, individuals using decoctions (fever grass, pawpaw and guava leaves) or not recommended antimalarial drugs exhibited high frequency of malaria within the year. The use of not recommended antimalarial drugs, despite their potential efficacy (Chukwuocha et al., 2016), might explain the recurrence in malaria infection as a consequence of poor efficacy or resistance to antimalarial medicines (WHO, 2018).

LIMITATIONS AND POTENTIAL BIAS

The definition and categorization of the different variables used in this study were based on declarations of interviewees, and may be prone to flaw, especially to potential memory bias. Also, the sample size was low, not allowing more accurate estimations of the knowledge, perceptions, habits and practices of the Obang Valley residents with regards to malaria and its control, and consequently the factors that could potentially explain the persistence and even the increase in prevalence of malaria in the study area despite the interventions implemented till now.

IMPACT ON POLICIES AND DECISIONS MAKING

Although preventable and treatable, malaria is still persisting in many settings, killing one child every two minutes worldwide (WHO, 2018). This inconvenient truth indicates that measures developed so far to tackle this deadly disease seems not enough or not fully implemented. Whatever the case, the populations suffering from malaria seems not implicated in the development of interventions or policies, and may not necessarily understand (i) the rationale behind each intervention, and (ii) the key role they need to play in the success of the strategy. Indeed, it has been demonstrated that appropriate health education of populations significantly improved the implementation of control measures, notably the uptake of LLIN (Amoran et al., 2012). Education of populations about malaria clinical signs, burden and appropriate prevention and treatment measures appears of high interest to dispel wrong beliefs of populations and therefore avoid/limit inappropriate habits in controlling the disease. This observation needs to be translated into policy to preserve the achievements reached so far in the fight against malaria, and enter the endgame phase towards elimination.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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ABBREVIATIONS

CI, confidence interval; **GTS,** Global Technical Strategy; **IQR,** interquartile range; **ITN,** insecticide-treated net; **LLIN,** Long Lasting Insecticidal Net; **MDG,** Millennium Development Goals; **SD,** standard deviation; **WHO,** World Health Organization.

REFERENCES

Amoran OE, Fatugase KO, Fatugase OM, Alausa KO (2012). Impact of health education intervention on insecticide treated nets uptake among nursing mothers in rural communities in Nigeria. BMC Research Notes 5:444.

Chukwuocha UM, Fernández-Rivera O, Legorreta-Herrera M (2016). Exploring the antimalarial potential of whole *Cymbopogon citratus* plant therapy. Journal of Ethnopharmacology 193:517-523.

FIS (2016). Shadow report: independant monitoring of the Global Fund Grants in Cameroon (CMR-M-MoH). For Impacts in Social Health (FIS), Yaoundé,

Cameroon.http://www.fiscameroon.org/sites/default/files/Rapports_E/Shadow%20anglais%20version%20finale.pdf. Accessed May 16, 2018.

Kleinschmidt I, Bradley J, Knox TB, Nnzava AP, Kafy HT, Mbogo C (2018). Implications of insecticide resistance for malaria vector control with long-lasting insecticidal nets: a WHO-coordinated, prospective, international, observational cohort study. Lancet Infectious Diseases 3099 (18)30172-30175. http://dx.doi.org/10.1016/S1473-3099(18)30172-5.

National Institute of Cartography (NIC) and Ministry of Economy Planning and Regional Development Cameroon (MINEPAT) (2013). National Atlas of Physical Development of Cameroon. https://fr.slideshare.net/ninonjopkou/positionnement-gographique-des-activits-conomiques-du-cameroun. Accessed May 16, 2018.

Ndoh Nbue I, Bitondo D, Balgah RA (2016). Climate variability and change in the Bamenda highlands of North Western Cameroon: perceptions, impacts and coping Mechanisms. British Journal of Applied Science and Technology 12(5):1-18.

Ndong IC, Van Reenen M, Boakye DA, Mbacham WF, Grobler AF (2014). Trends in malaria admissions at the Mbakong Health Centre of the North West Region of Cameroon: a retrospective study. Malaria Journal 13:328.

Russell CL, Sallau A, Emukah E, Graves PM, Noland GS, Ngondi JM, Ozaki M, Nwankwo L, Miri E, McFarland DA, Richards FO, Patterson AE (2015). Determinants of bed net use in Southeast Nigeria following mass distribution of LLINs: Implications for social behavior change interventions. PLoS ONE 10(10):e0139447.

Thomsen EK, Koimbu G, Pulford J, Jamea-Maiasa S, Ura Y, Keven JB, Siba PM, Mueller I, Hetzel MW, Reimer LJ (2017). Mosquito behavior change after distribution of bednets results in decreased protection against malaria exposure. Journal of Infectious Diseases 215(5):790-797.

World Health Organization (WHO) (2014). From malaria control to malaria elimination: a manual for elimination scenario planning. World Health Organization, Geneva. ISBN 978 92 4 150702 8.

World Health Organization (WHO) (2015a). Global technical strategy for malaria 2016-2030. World Health Organization, Geneva. ISBN 978 92 4 156499 1.

World Health Organization (WHO) (2015b). Achieving the malaria MDG target: reversing the incidence of malaria 2000-2015. World Health Organization, Geneva. ISBN 978 92 4 150944 2.

World Health Organization (WHO) (2017a). World Malaria Report 2017. World Health Organization, Geneva. ISBN 978-92-4-156552-3.

World Health Organization (WHO) (2017b). A framework for malaria elimination. World Health Organization, Geneva. ISBN 978-92-4-151198-8.

World Health Organization (WHO) (2018). Malaria. World Health Organization Fact Sheet. Updated 11 June 2018. http://www.who.int/news-room/fact-sheets/detail/malaria. Accessed July 20, 2018.

Xu JW, Liao YM, Liu H, Nie RH, Havumaki J (2014). Use of bed nets and factors that influence bed net use among Jinuo ethnic minority in Southern China. PLoS ONE 9(7):e103780.