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Impact of using Long-Lasting Insecticide-treated Mosquito Nets on malaria parasitaemia in the outskirts of Kisangani.

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Abstract

Introduction: Notwithstanding the large-scale use of mosquito nets and peri and intra-residential sanitation measures to control malaria in DR Congo, malaria remains the first of the deadliest diseases. The purpose of this study was to measure the impact of mosquito net use on malaria parasitaemia.

Subjects and methods: We carried out an analytical cross-sectional study from 21 September to 17 December 2015. Two hundred and fifty-two subjects aged ≥ 5 years, living in the villages of Madula and Wanierukula (30 and 58 km from Kisangani), using a mosquito net in good condition every day, or not at all, were included. Pregnant women and subjects who took antimalarial treatment in the last two months before the study were excluded.

Results: The mean malaria parasitaemia in subjects who used a net was 439.2 parasites / µl, less than half of those who did not use a net (895.5 parasites / µl). On the other hand, in those who slept after 22:00, the use of the net did not influence their malaria parasitaemia.

Conclusion: The use of the mosquito net reduces asymptomatic parasitaemia in half in those who use nets in the outskirts of Kisangani. It shows certain limits, among other things, a not insignificant malaria parasitaemia, even in the subjects who use it regularly and a low efficiency in the subjects who used it after 22h00. It deserves to be reinforced by other prevention methods such as the spraying of residual insecticides.

Keywords: LLIN, malaria parasitaemia, children, Kisangani, DRC

Malaria is the world's first parasitic endemic (1). It is a febrile erythrocytopathy caused by protozoa of the genus plasmodium and transmitted to humans by anophele insect bite [2].

It is estimated there are about 300 to 500 million clinical cases of malaria worldwide. This pathology has several severe forms that cause about 679,000 deaths, especially in children under 5, despite recent

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advances in its knowledge and management (3,4). It is in intertropical Africa, where malaria is endemic and epidemic, that the situation is by far the most worrying (5,6). The Democratic Republic of Congo (DRC) is the world's second most affected country after Nigeria. The transmission of this disease is almost permanent in the DRC, 97% of the population lives in areas where transmission is permanent (7). Malaria statistics are alarming with nearly 27 million cases, including 180,000 deaths per year (7). Malaria has, in fact, decreased in recent years in all regions of the world as a result of the joint improvement of vector control (massive distribution of long-lasting insecticide-treated mosquito nets [LLINs] and indoor sprinkling of insecticides), rapid diagnosis of plasmodial infections (rapid diagnostic tests (RDTs), effective treatments (artemisinin derivatives-based combination therapies [ACTs], intermittent presumptive treatments [TPI] pregnant women and children), social (urbanization, economic development) and climate change (8). In the DRC, the major strategies adopted by the National Malaria Control Program (NMCP) to control malaria vectors were large-scale use of LLINs and peri- and intra-household sanitation measures. Among the targets set by this program was also the spraying of at least 80% of the homes in the intervention areas with residual insecticides from 2011 to 2015(8). However, implementation of this strategy in Kisangani and its surrounding areas has remained limited to the distribution of LLINs, peri and intra-residential sanitation and spraying of houses with residual insecticides is not yet available. In addition, national health statistics indicate that malaria was still at the forefront of deadly diseases in the DRC. At the time of scale-up of high impact interventions for malaria, the persistence of asymptomatic parasitaemia in the indigenous population was worrying as it could be a reservoir of parasites, a threat to the achievement of malaria elimination (9). For this reason, the purpose of this study was to measure the impact of long-lasting insecticide-treated bed nets on malaria parasitaemia in the outskirts of Kisangani. This will allow us to conclude whether the use of LLIN in Kisangani is benefic or whether it really has a significant impact that should be encouraged.

Subjects and methods

Settings of the study

Our study was conducted in the villages of Madula and Wanierukula located 30 and 58 km north of the city of Kisangani respectively. Kisangani is the capital of the Province of Tshopo in DRC. Both villages enjoy an equatorial climate. Endemic malaria is rampant in this region, with exacerbations during rainy seasons. However, four months before our study, residents of both villages benefited from a free LLIN distribution campaign.

Type of study

This is a cross-sectional analytical study conducted from 21 September to 17 December 2015. This period covers the second rainy season of the year, which generally starts around mid-September and ends around mid-December. .

Study population

The study was conducted among the inhabitants of these two villages aged at least 5 years. The subjects were included in the study with healthy LLINs (in good condition and free of holes) and using it every night for at least two months or with no LLIN at all. Subjects who took antimalarial treatment in the last two months before this study and pregnant women were excluded from the study.

Sampling and sample size.

The sampling was of convenience. A minimum sample of 252 subjects, 199 subjects using the LLIN and 51 not using nets, were selected to carry out this study.

Data collection

The study focused on the sociodemographic characteristics of the subjects, the use of LLIN, and malaria parasitaemia. Sociodemographic data and use of LLIN were collected using an interview. Data included age, gender, occupation or occupation, usual bedtime and use of LLIN. The blood for the preparation of the thick drop and the determination of the parasite density was done in the field, while the staining and reading were performed at the laboratory unit of the 'Hopital du Cinquantenaire in Kisangani. On a thin smear, using an optical microscope, parasites were counted per microliter of blood. For the calculation of the parasite density (DP), the formula below (WHO February 2009) was used:

$$DP = \frac{\text{number of enumerated white cells* } 8000/\mu l}{\text{number of counted white cells}}$$

Statistical analyzes

Data were analyzed using SPSS Version 20. We used the Chi square test to compare the proportions of LLIN use by the different groups and the student's t test to compare malaria parasitaemia means of different groups. The statistical significance threshold was set at 5%.

Ethical consideration

Before being included in the study, respondents were clearly informed of the survey's objectives. Consent was either obtained orally or in written form from adults and parents under 15 years of age before the administration of the questionnaire and blood collection. Furthermore, to ensure confidentiality, we adopted a code system on data collection forms using numbers and letters.

Results

Sociodemographic characteristics of the respondents

In **Table 1**, a total of 252 subjects aged 5 to 65 participated in the study; 91.7% of the respondents were over the age of 10, with a sex ratio of 1.1 to 1 in favor of the male; 90.9% of respondents reported that they go to bed by 22:00.

Proportion of use of LLIN by respondents

The observation in **Table 2** shows that the proportion of LLIN use by our respondents was 79.0%. Respondents aged 5 to 10 years were more likely to use LLIN than those older than 10 years, with a statistically significant difference. (p: 0.04).

In terms of gender and bedtime, there were no statistically significant differences in the use of LLINs. In contrast, married subjects used LLIN more than unmarried subjects with a statistically significant difference (p: 0.00).

Malaria parasitaemia among respondents

The mean parasitaemia of our subjects was 535.2 parasites / µl. The analysis in **Table 3** shows that mean parasitemia in subjects using LLIN was 439.2 parasites /µ l. It accounts for less than half of the mean malaria parasitaemia in subjects who did not use LLIN (895.5 parasitaemia / µl), with a statistically significant difference (p: 0.003). It was also noted that malaria parasitaemia was significantly higher (p: 0.002) in subjects who slept before 22:00 and who did not use LLIN (819.7parasites / µl) compared to those who slept at the same time and who used LLIN (377, 2parasites / µl). In contrast, in subjects who slept after 22:00, there was no statistically significant difference in malaria parasitaemia between those who used LLIN and those who did not.

Discussion

The results of this study show that the utilization rate of LLINs in the outskirts of Kisangani was estimated at 79.0%. This rate of use was lower in subjects over

10 years of age and in unmarried subjects. According to the 2015 WHO Malaria Report, in sub-Saharan Africa more than 50% of the population sleep with LLINs, compared to 2% in 2000 (10). An investigation by Fissou et al. in Chad in 2016, on the perception of malaria risks and the use of mosquito nets, showed that 80.6% of respondents reported having using LLINs. According to the authors, this property rate obtained in Chad was due to the highly decentralized and free distribution of LLINs; one LLIN for two persons per household; one for each pregnant woman at the first contact of the preventive consultation; a LLIN for any newborn seen during the first routine vaccination. All of these strategies have allowed many households to have LLINs. However, in the same study, respondents' LLIN utilization rate was 50.4%, lower than the 80.6% found in this study. This low utilization rate was justified by a misperception of the community, for which LLINs did not seem to be effective tools for malaria control, but rather a means of controlling the nuisance caused by mosquitoes (11).

Table 1. Sociodemographic characteristics of the respondents

Characteristics	n	%
Age groups		
≤ 10 years	21	8,3
> 10 years	231	91,7
Sex		
Male	130	51,6
Female	122	48,4
Marital states		
Married	145	67,5
Not married	107	42,5
Sleeping time		
Before 22:00	229	90,9
After 22:00	23	9,1

Table 2. Proportion of use of LLIN compared to different groups of respondents
Groups Total (%)

Groups	Total (%) 252 (100)	Use of LLINs (%) Yes : 199 (79)	No : 53 (21)	P
	n (%)	n (%)	n (%)	
Age groups				
≤ 10 years	21 (100)	20 (95,2)	1 (4,8)	0,04
> 10 years	231 (100)	179 (77,5)	52 (22,5)	
Sex				
Males	130 (100)	103 (79,2)	27 (20,8)	0,519
Females	122 (100)	96 (78,7)	26 (21,3)	
Marital status				
Married	145 (100)	126 (86,9)	19 (13,1)	0,00
Not married	107 (100)	73 (68,2)	34 (31,8)	
Sleeping time				
Before22 :00	229 (100)	179 (78,2)	50 (21,8)	0,244
After 22 :00	23 (100)	20 (87,0)	3 (13,0)	

In the Mumbunda Health Zone in Lubumbashi, DRC, Cilundika and al. estimated the LLIN utilization rate at 80.2%. According to these authors, this could be explained by the fact that the population decided, in this Health Zone, to protect everyone against malaria through this means, including the most vulnerable who are children (12). In our study, the high rate of LLIN usage is the result of LLIN awareness and distribution campaigns conducted by the National Malaria Control Program with its Partners in Kisangani and surrounding areas. With regard to parasitaemia of malaria, the present study showed that the mean parasitaemia of our asymptomatic subjects was 535.19 parasites / µ1. In subjects who do not use LLINs, this asymptomatic parasitaemia was performed by Zaba F et al. In 2014, on the profile of blood counts in children aged 0 to 5 years with malaria at the Ivorian University Hospital of Yopougon, in Abidjan, had determined the parasitic malarial children on average 7432 ± 3239 with extremes of 500 and 70,000 trophozoites / mm3 (13). The study conducted by Jean-Philippe C et al in Cotonou, on the pathogenic threshold of malaria parasitaemia, showed that in children, the limit of pathogenic parasitaemia was between 3,000 and 6,000 trophozoites per mm3 of blood. In adults, this pathogenic threshold appears to be less than 1000 trophozoites per mm3 of blood. It appears that the asymptomatic mean parasitaemia of our subjects, in particular those who have not used LLINs, is equivalent to the pathogenic threshold determined in the aforementioned studies. This is explained by the fact that our study was conducted in a highly endemic area of malaria where infestations bites provide the subjects with a premonition or protection against malaria and increase the threshold pathogen.

Regarding the impact of LLIN use on malaria parasitaemia, our study showed that the use of LLINs has a significant impact on malaria parasitaemia. In this study, subjects who did not use LLINs had a parasitaemia quantified twice that of those who used it. Differences were statistically significant between subjects who used LLINs and those who did not, regardless of age, sex, or marital status. The same is true for subjects who slept before 22:00; those who used the LLIN had a lower mean parasitaemia of malaria than those who did not use it. A study conducted by Sompwe Eric et al. on asymptomatic parasitaemia in children under 5, school-age children, and febrile episodes in households in Lubumbashi, determined the average parasite density at 1527 parasites /µl. This study showed, like ours, that the use of LLINs has an influence on malaria: children who spent the night under LLIN were 5 times more protected against malaria than those who did not (14). This parasitaemia is twice the average of our population. This difference is explained by the fact that his study population is composed mainly of under five

Table 3. Parasite malaria in relation to the different characteristics of the respondents

Characteristics Average parasite (parasites / µl)

Characteristics	Means parasitemia (parasites/µl)		P 0,003
	Use LLIN (*439,2)*	Do not use LLIN (*895,5)*	
Age groups			
≤ 10 years	440,1 (0-2236)	1874,3 (-)	0,048
> 10 years	439,1 (0-5119)	876,7 (0-4705,9)	0,011
Sex			
Male	418,4 (0-4504,8)	912,9 (0-4705,9)	0,036
Female	461,5 (0-5119,6)	877,6 (0-4271,2)	0,074
Marital status			
Married	477,9 (0-4504,9)	845,2 (0-4705)	0,11
Non married	416,8 (0-5019,6)	885,7 (0-3846)	0,025
Sleeping time			
Before22 :00	377,2 (0-5019,6)	819,7 (0-4705)	0,002
After 22 :00	994,6 (0-3242,2)	1159,4 (0-3478,3)	0,84

children, whereas ours is composed of participants over 5 years old, who have already contracted a malaria premunition. However, the value of using LLINs tested by both our study and those of other authors is not the best method of prevention because it is tainted with a certain degree of risk of asymptomatic malaria and malaria. This is the case of subjects who have used LLIN after the normal sleeping time. Our study showed that for subjects who usually slept after 22:00, the use of the LLIN did not show its impact. Mean malaria parasitaemia between those who used it and those who did not use it was not statistically significant. This can be explained by the fact that the use of LLIN generally only protects anopheline bites in bed and allows to say that the time spent by subjects outside the LLIN should be supplemented by others different protective measures against mosquito bites including an insecticidal spray. This observation was also made by Fullman N et al. They showed in their study that the reduction of malaria-related morbidity and mortality can be achieved by combining the use of LLINs with a household aerosol insecticide and that this combination is more effective than either of these interventions individually (15).

Conclusion

The use of LLINs has an impact on malaria parasitaemia on the outskirts of Kisangani. It halves asymptomatic parasitaemia in those who use it. However, it shows some limits among others a parasitaemia paludism not insignificant, even in the subjects who nevertheless use it regularly. In addition, it is less effective in subjects who use it after 22:00. This is why it deserves to be reinforced by other prevention methods such as the spraying of residual insecticides.

Conflicts of interest

The authors declare no conflict of interest.

Authors' contributions

Marcel SabitiPoyo designed the study, developed the protocol, collected the data, collected and analyzed the data and wrote the article. Antoine Tshomba Oloma, Paul Kambale Kombi, François Masudi Poyo, Révocat Bulabula Ali, Ernest Amsini Safiri and Désiré Oleko Wa Oleko participated in the revision of the manuscript.

Charles Kayembe Tshilumba participated in the final writing of the manuscript. All authors read and approved the final manuscript.

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