Surveys on Familial and Individual Knowledge, Attitudes and Practices (KAP) on Mosquitoes and Malaria Vector Control in Lobito (Angola)

V. Foumane a, J. C. Toto a, A. Moniz Soyo b, G. Carnevale c and P. Carnevale d*

a Pan African Organization of Cooperation and Coordination for the Control of Endemic Diseases in Central Africa (OCEAC); PO 288, Yaoundé, Cameroon.

b Malaria Control Program, Medical Department, Sonamet Company, Lobito, Angola.

c Hygiene, Safety, Quality, Environment, Gianyar, Bali, Indonesia.

d Le Majoral Building, Portiragnes, 3420, France.

Authors’ contributions

This work was carried out in collaboration among all authors. Author PC prepared the protocol, was involved in field surveys, analyzed data and wrote the draft document. VF trained interviewers coordinated and monitored field surveys and did first analysis of data; authors JCT and AMS were involved in field surveys; author GC was involved in the English version. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/SAJSSE/2021/v12i430341

Editor(s):
Dr. John M. Polimeni, Albany College of Pharmacy and Health Sciences, USA.

Reviewer(s):
(1) Belquis Abdullah Ahmed Farea, Ministry of Health, Yemen.
(2) N. Kalaiarasi, SRM Institute of Science and Technology, India.

Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: https://www.sdiarticle5.com/review-history/80618

Received 15 October 2021
Accepted 20 December 2021
Published 22 December 2021

ABSTRACT

A cluster sampling survey was implemented in Lobito town (Angola) before the scheduled large distribution of long lasting insecticide treated nets in the framework of the National Malaria Control Program to get base line data on the knowledge, attitude and practice (KAP) of population against mosquitoes and vector borne diseases. A total sample of 420 households (representing 2384 inhabitants) was involved and interviewed and it appeared that 94% of them complained against mosquitoes as biting and boring nuisance while 22% reported their fear about vector borne diseases. 94% are developing some method against mosquitoes at household level, mainly commercial insecticide spray cans (57%) bednets (53%), mosquito coils (38%) and often several methods are used (such as spray before sleeping then bed net or coils during the night). It was reported an average of 2.4 bed/house but only 1 bednet/house showing the need for procuring

*Director of Research.
*Corresponding author: Email: pjc carnevale2001@yahoo.fr;
nets for everyone. The main reasons for non-using nets are “uncomfortable” (reported by 30% while it was only 10% by people actually using the net!), hot, not easy to use while the costs did not appear as the main problem. The estimated cost of mosquito control at household level was estimated at around 2 to 4 $/month 25% of households declared having had a child sick during the last 15 days with a cost around 5 to 10 $ US; cost which was similar for treatment of child or adults. It would be interesting to implement such KAP surveys after the distribution of LLIN in the framework of the National Malaria Control and underline changes in perception and use of mosquito/malaria vector control at household level.

Keywords: KAP surveys; vector control at household level; expenditures for mosquitoes control and for malaria treatment.

1. INTRODUCTION

The recent Malaria WHO fact sheets of 6 December 2021 underlined the following key facts:

- In 2020, there were an estimated 241 million cases of malaria worldwide and 227 million in 2019.
- The estimated number of malaria deaths stood at 627 000 in 2020 an increase of 69 000 deaths over the previous year.
- The WHO African Region carries a disproportionately high share of the global malaria burden. In 2020, the region was home to 95% of malaria cases and 96% of malaria deaths. Children under 5 accounted for an estimated 80% of all malaria deaths in the Region.
- Four African countries accounted for just over half of all malaria deaths worldwide: Nigeria (31.9%), the Democratic Republic of the Congo (13.2%), United Republic of Tanzania (4.1%) and Mozambique (3.8%).

Angolan population (# 30 million) is at risk for malaria all over the country, but transmission patterns vary by geographic location. Malaria is considered as the fourth causes of death (after diarrhoeal diseases, neonatal disorders, and HIV). It was officially reported that more than 2 million malaria cases occurred in 2020 with more than 2500 deaths and malaria could still considered as a main cause of morbidity and child mortality in Angola [1, 2]. A comprehensive Malaria Control Program was launched including vector control, case management with Rapid Diagnostic Test (RDT), improvement of diagnostic [3] and Artemisinin Combined Therapy (ACT) [4], Intermittent Presumptive Treatment (IPT) for pregnant women etc.

Vector control is based upon nationwide free distribution of Long Lasting Insecticide Treated Nets (LLIN), focal Inside Residual Spraying, but several issues were already encountered [5] and larviciding with Bacillus thuringiensis mainly in town, while waiting for an operational vaccine.

The efficiency of LLIN is linked to the insecticide susceptibility of targeted vectors and current spreading of resistance to pyrethroid is a matter of concern [6-8], actual community participation [9], one of the main issues is to get, and maintain, an universal coverage and use [10]. This point requires a sound knowledge of usual perceptions and practices of targeted populations in term of malaria and mosquito control at family and individual level.

A great lot of KAP surveys were implemented in Ethiopia [11-16], Tanzania [17-20], Sudan [21], Swaziland [22, 23], Nigeria [24-26], Burkina Faso [27], Cameroon [28-30], Uganda [31-33] among several other.

Long lasting insecticide treated nets were successfully tested in Angola, in Lobito at family level [34, 35] and at village scale around Balombo [36, 37].

Entomological surveys showed that in Lobito the main vector are Anopheles coluzzii and An. gambiae according to the part of the town and the season while abundant An. listeri are present in the lower part of the town [38]. Huge population of Culex quinquefasciatus is observed due to stagnant polluted water induced by inadequate drainage and sanitation, and Aedes aegypti was caught with ovitraps and in anthropic containers in different part of the town [39].

It was reported that Anopheles gambiae are still susceptible to pyrethroid insecticide while Culex quinquefasciatus are already strongly resistant [40].
Parasitological and clinical surveys showed that “Malaria” constitutes a great part of medical consultation but an important overdiagnosis was observed [41,42] and the reliability of data from Peripheral Health Centre could be questioned [43]. As recently reported a majority of true malaria cases seeking care in health facilities in Huambo [town close to Lobito] were not appropriately treated with anti-malarials, highlighting the importance of continued training and supervision of healthcare workers in malaria case management, particularly in areas with decreased malaria transmission [4] such as the situation could became with vector operations scheduled and implemented.

Recent official presentation reported a critical situation in the main hospital of Benguela, mainly in the pediatric department which reported 150 deaths of malaria and malnutrition in April 2021.

The National Malaria Control Program (NMCP) provide long-lasting insecticide treated mosquito nets and perform mosquito surveillance but it appeared worth implementing also human behaviour studies to adapt Information, Education, Communication (IEC) campaign and increase the use and maintenance of LLIN, some surveys in Balombo area have showed that 50% of population could have removed their nets from the bed in 3 years [44] while sometimes keeping the nets inside the house, this confirming the well-known point that to have doesn’t mean to use.

The aim of the survey was to precise the current attitudes of the targeted population in term of mosquito control at household level and the main reasons for using or not mosquito nets to avoid as much as possible the already noticed (in Angola as elsewhere) withdraw, or misuses, of nets procured by the NMCP or other stakeholders.

2. MATERIALS AND METHODS

2.1 Lobito (Benguela Province) [12°22’S; 13°32’E].

Surveys were carried out in Lobito town (# 400,000 inhabitants) built on a sandspit and reclaimed land, where was developed the Angolese private company Sonamet® which supported these studies through its Malaria Control Program (MCP). Lobito was already described during the former entomological studies [34, 38] and clinical observations [43]. It is characterized by a lower part, at sea level, and thus with important pools of stagnant more or less polluted water suitable for mosquitoes (pictures) and an upper part (Bella Vista) where settlement are greatly increased but lack of running water was an important issues (pictures); therefore people built some tanks near their house to keep water for domestic usage but which are suitable breeding sites for An. gambiae (pictures).

Meteorological conditions are characterized by relatively constant temperature (average 24.1°C) (with a cold season in July and August) but well-marked rains, from October to April and an average of 354 mm/year (graph.1).

Fig. 1. In April alone, 150 children died of malaria and malnutrition in Benguela
2.2 Sampling

Study was done in houses randomly identified following the classical cluster sampling method already implemented for KAP surveys in Cameroon [28, 29] and involving the different parts of the city according to their size. Two surveys were done: one month, from 24 May to 28 June 2011 (23 clusters studied) then one week 26 to 30 August 2011 (7 clusters) to get the sample size of 30 clusters of 14 households each and the 420 households needed.

Questionnaires were also devallopped from the Cameroon model, with open and closed questions, translated in Portuguese and tested to avoid any misinterpretation then finalized according information gained by the first interviews.

The field work was conducted with agents of the Malaria Control Program of Sonamet after prior training in the use of the questionnaire.

In case of refusal the survey considered the nearest house following the methodology used in Cameroon.

2.3 Information

The questionnaire was composed of 3 parts:

- description of the close environment of the house (stagnant water, grasses, etc.), obvious breeding place with/without mosquitoes etc., observation done by the questioner before entering the house;
- interview with the head of the family (and noting the composition of the family) at 2 levels:
  o mosquitoes issues: protection against mosquitoes? why? why not? How? when? Use of nets? Yes/not, why/why not; which one? Received or bought? And where? When? knowledge of ITN/LLIN ? etc and
  o diseases issues: recent cases of fever, behaviour in case of fever, etc. Open question to get as much as possible the feeling of the inhabitants;
- the third part dealt with the costs, as estimated by the head of the household, costs of mosquitoes control, costs of disease management at house or Health Center level.

2.4 Data Processing and Statistical Analysis

Data were processed with Epi Info Version 6.04c. Confidence intervals were calculated with the exact binomial method, and a risk of error of 5%. The statistical tests used were the classical Chi² test or Fisher for proportions, analysis of variance or test Kruskal-Wallis for the mean or median, depending on the requirement for statistical validity of comparisons. The level of significance was set at P value ≤ 0.05.
3. RESULTS

3.1 Status of the Respondent and Household Composition

Among the 420 households surveyed, interviewees were mainly parents (68.9% (51.8% mothers and 17.1% fathers), older children (27.8%) and other members of the family (3.3%).

The whole population of houses surveyed was 2,384 people which gave an average of 5.7 inhabitants/house; and the average composition of families was: 0.4 children less than 1 year; 2, 1 children 1-15 years and 3.1 adults over 15 years. 36.1% of families surveyed had no children under 1 year.

3.2 Main Characteristics of the Habitat and its Environment

Houses surveyed were mainly detached houses (53.7 %), terraced houses (26.8%), modern villa (12.6%) and 6.9% a single room.

Walls were mainly made of cement (77.1 %), mud (22.6%) and small different kind of material (0.2%).

Water collections were present around houses in 48.2 % of them (203/420); vegetation within 20m was noticed for 342 houses (i.e. 81.4%), it was sparse for 255 houses (i.e. 74.6 %), and abundant for 5%.

Potential water tanks (old boxes, tires, etc.) were observed around 334 houses (79.5%); they were considered as not abundant in 244 houses (73.1 %) and abundant in 6.9%. Old discarded tires were often observed and are potential and actual breeding sites for Aedes aegypti inducing high risks of yellow fever or other arbovirus outbreaks.

The average number of beds per house was 2.4 (± 0.9), minimum1; maximum 6; median 2.

3.3 Perception of Mosquitoes Issues

94.3% of interviewees said mosquitoes are annoying; biting (83.3%) and noisy (62.8%) being the main causes of complaints; it is worth underlining that disease transmission was reported in 22.1% of answer.

3.4 Protecting Behaviour against Biting-boring Mosquitoes at Family Level

Interviewees were asked about their behaviour against mosquitoes; 93.6% (393/420) reported implementing regularly some protection against bites (Table 1), 57% used classical commercial spray cans and 53 % have beds; 213/420 (50.7%) used more than one method protection while 6.4% were doing nothing.

The large use of coils, and their efficacy in Cameroon, was already reported [45].

3.5 Availability and Use of Mosquito Nets

Two hundred and twenty-two of the 420 households surveyed had at least one bed net (#53%) with a total number of 438 nets (i.e. 1.04 net ±1.03 net per household) protecting 795 inhabitants, (= 33.3% of the whole population of the surveys) (Table 2).

53% of babies of the sample slept under mosquito nets, 35% of kids (1-15 years old) and 30% of adults (Table 2).

3.5.1 Issues of nets

35% of households without nets reported their “uncomfortable usage”, 31% too hot; 12% not easy to use and costs is reported only by 2% as a reason for not using nets (Table 3).

These percentages were respectively 10%; 13%; 3% and 0.4% in households with nets.

Table 1. Main methods implemented in Lobito against mosquitoes at family level

| Methods                | number (n=420) | %         | SD 95%*     |
|------------------------|---------------|-----------|-------------|
| Insecticide spray cans | 239           | 56.9%     | 49.9 - 63.6 |
| bednet                 | 222           | 52.8%     | 45.9 – 59.7 |
| Mosquito coils         | 150           | 35.7%     | 29.3 - 42.6 |
| Window nets            | 28            | 6.7%      | 3.8 – 11.2  |
| Repellents             | 3             | 0.7%      | 0.08 -3.4   |
| Pacote                 | 1             | 0.2%      | 0 – 2.6     |
| nothing                | 27            | 6.4%      | 3.6 -10.9   |
### Table 2. Percentage, by age group, of inhabitants sleeping under mosquito net in Lobito

| Age group                | Number sleeping under net | %   | SD 95%                  |
|--------------------------|---------------------------|-----|-------------------------|
| Babies <1 year (n=167)   | 89                        | 53.3% | 42.1 - 64.2            |
| Kids 1-15 years (n=898)  | 318                       | 35.4% | 31.0 - 40.1            |
| Adults >16 years (n=1319)| 388                       | 29.4% | 25.9 - 33.1            |
| Total (n=2384)           | 795                       | 33.3% | 30.7 - 36.1            |

### Table 3. Issues mentioned for the non-use of nets

| Issues                  | Households without nets n=192 | Households with nets n=228 | P   |
|-------------------------|--------------------------------|----------------------------|-----|
| Uncomfortable use       | 67 (34.9%)                     | 23 (10.1%)                 | <0.005|
| Warmth                  | 59 (30.7%)                     | 29 (12.7%)                 | <0.005|
| Not easy to use         | 23 (12.0%)                     | 8 (3.5%)                   | <0.005|
| Cost                    | 4 (2.1%)                       | 1 (0.4%)                   |     |
| Ineffective             | 0 (0%)                         | 1 (0.4%)                   |     |

### Table 4. Episodes morbid and cost within 15 days preceding the interview

| Indicators                           | Children (≤15 years) | Adults > 16 years | Statistical analysis                  |
|--------------------------------------|----------------------|-------------------|---------------------------------------|
| sick                                 | 120/1065 (11.3%)     | 86/1319 (6.5%)    | $X^2 = 16.82; P < 0.005$               |
|                                      |                      |                   | OR= 1.82 [1.36-2.43]                   |
| Households having had at least 1 patient | 104/420 (24.8%)     | 75/420 (17.9%)    | $X^2=5.97; P=0.0145$                   |
|                                      |                      |                   | OR= 1.51 [1.08-2.11]                   |
| Households which gave the estimated cost of the disease | 44/104 (42.3%) | 20/75 (26.7%) | $X^2=4.64; P=0.031$                   |
|                                      |                      |                   | OR= 2.02 [1.06-3.83]                   |
| Patients with the estimated cost of the disease reported | 52/120 (43.3%) | 24/86 (27.9%) | $X^2 = 5.12; P=0.023$                   |
| Estimated cost of the disease (US$) | 4.73 (±5.37)         | 4.70 (±5.80)      | OR= 1.97 [1.09-3.58]                   |
It thus clearly appeared that non-users maximized the issues of nets and this justify the development of Information campaigns.

The estimated costs of nets (from 169 answers) was 0.57 $ (±0.43 $) i.e. around 1 $ US which explains that their costs was not considered as their main issue.

3.6 Knowledge on Insecticide Treated Nets (ITN)

Three hundred fifty-seven households (85%) are aware of ITNs, 281 of them (66.9%) declared being ready to use. After providing families with information on the existence of ITNs which can kill mosquitoes and avoid diseases, 354 households (84.3%) would be willing to get, at an average price of 0.26 $ (+- 0.27 $) i.e. two times less than the estimated cost of a net at the market level.

3.7 Monthly Reported Costs of Protection against Mosquitoes at Family Level

306 interviewees gave an estimate of the cost of their current behaviour against mosquitoes at family level, the monthly average reported was 2.25 $ US (± 1.53 $) with a median of 1.77 $ and a maximum of 7.08 $.

3.8 Morbid Episodes Associated with Mosquitoes and Cost within 15 Days Prior the Surveys

During the 15 days preceding the interview, illness (whatever it was) episodes, associated by people to mosquito bites, and their estimated costs, are gathered in Table 4.

Children were significantly sicker of mosquitoes borne diseases than adults (respectively 11.3% and 6.5%). The same significate trends was reported from the 420 households surveyed: #25% having had one child sick and # 18% with one adult sick during the last couple of weeks.

It is interesting to notice that the estimated costs of the treatment was similarly reported at household or patients level and the estimated cost for treatment was similar for child and adult (# 5 US $).

We unregistered the reported costs without any check to be always completely neutral.

4. DISCUSSION

One of the most important ways for improving malaria vector control is to understand factors affecting the adherence of communities to vector control interventions [46].

Several studies on the behaviour of population against mosquitoes were done before the availability of long lasting insecticide treated nets ("LLIN") [28,29,47-49] and after [50,51].

The KAP survey done in Lobito (Angola) before the scheduled large scale distribution of insecticide treated nets by the National Malaria Control Program showed that, as noticed elsewhere, the nuisance (biting, noisy) is the main cause of mosquito control at household level. People use mainly commercial insecticide spray cans, and mosquito coils, but some 50% used bednets mainly to protect babies. It was reported an average of 2 beds by house but only 1 bednet, which underlined the clear need of scaling-up long lasting insecticide treated mosquito net distribution. But the pyrethroid resistance of Culex quinquefasciatus is a matter of concern [40], if mosquitoes are still present in spite of treated nets people could consider them as useless and do not use as expected even if they maintain some efficacy against Anopheles malaria vectors. A point which has to be seriously taken into consideration for the choice of LLIN [52,53] [54,55] or combination of malaria vector control interventions in pyrethroid resistance areas [56,57] and the sensitization messages.

The population awareness about the bed nets and their willingness to use them if easily available will facilitate their diffusion in the country. A cross-sectional malaria KAP Survey performed at the household level in Cape Verde a country in the pre-elimination context [58] reported that more than 97% have heard about mosquito nets but only 19% used them. In practice, 53% use coils, 45% rely on household sprays and 43% have benefited from IRS while some gaps and misunderstandings have been noticed and contribute to the insufficient community involvement in actions against malaria. Therefore, it is crucial to increase the knowledge of the population, leading to their full ownership and participation in community actions to contribute to the malaria elimination in the country.
Fig. 2. Stagnant water, with larvae of *An.gambiae* (picture PC)

Fig. 3. Stagnant water and gutter with polluted water = breeding site for *Culex quinquefasciatus* (picture PC)
Tomass et al. did KAP studies in Southern Ethiopia [50] showed that optimal use of long-lasting insecticidal (LLINs) for malaria prevention depends on mass distribution, the users' perception and behaviour of local malaria vectors. The average family size in the surveyed households was 5.25 (±0.70 SE, range 1-12). The majority (81.1%) of the households owned at least one LLIN. The average numbers of LLINs being used and sleeping places in the households were 1.61 (0.04 SE, range 0-4) and 2.27(0.03 SE, range 1-6), respectively.

While the majority of households owned at least one LLIN at the time of interview about only 53% of them hang LLINs above their sleeping location every night. These data, in term of family size and around one LLIN /household are well in line with the observations done in Lobito.
For Tomass et al (loc. cit.) there was discrepancy between the average family size and the average number of functional LLINs owned by the households at the time of the survey. This raised the issues of the WHO target of allocating one LLIN for every two people in the household [59]. The disproportion also existed between the average numbers of nets, and average number of sleeping places (including temporary places outdoor), which was 2.27 (0.03 SE, range 1–6).

A study was recently done to assess the knowledge and practices of communities living in four eco epidemiological settings in Cameroon with different cultural backgrounds [46]. The proportion of households possessing at least a net was high in the four study sites, this might be linked to the free distribution campaigns of LLINs to the population carried out by the NMCP. But the proportion of households possessing one bed net for two people was, however, significantly low and was consistent with previous findings in the city of Yaoundé [60]. It was also noted that some people used treated nets in agriculture for the protection of young plants and for fishing and farming; these poor practices have been highlighted in previous studies [61, 62] and request further attention.
Fig. 7. Collecting *Anopheles* larvae in a tank with domestic water near a house in Bela Vista (picture PC)
This was also noticed in villages around Balombo where the project gave, free of charges, enough LLIN to protect every sleeping units [36].

This survey was done before the scheduled large scale free of charge distribution of LLIN by the National Malaria Control program and it will be worth doing the same after this vector control operation to precise to eventual changes (or not) of behaviour and attitude towards mosquitoes and malaria vectors for further IEC and LLIN distribution.

5. CONCLUSION

In Lobito, as it was well noticed elsewhere such as, for example, in Douala and in Yaoundé, people complained mainly about the nuisances due to mosquitoes, bite and sound, then their role as vector borne disease and malaria being one of them. At household level people used mainly the classical spray cans easily found in the market as well as coils (while their content is matter of concern), bednets are also used but not for every “bed” (or sleeping unit). The trends to protect mainly babies is an important information for the National Malaria Control Program which could put, with the community, a special emphasis on the protection of “under five” where malaria has still the main impact and expect therefore a sharp reduction of malaria burden.

The information gained with KAP surveys allowed the preparation, and implementation, of “tailored” program of sensitization of targeted community and the monitoring of the operations such as large scale distribution of insecticide treated nets) for the best cost/effectiveness output.

6. RECOMMANDATION

Considering the impact of malaria with the worsening situation of drug and insecticide resistance in Angola such as elsewhere;

Considering the need of an actual community participation in the different method of malaria control and especially in vector control at household level;

Considering that up to now Long Lasting Insecticide Nets are the main tool for vector control but their proven efficacy is linked to their sustainability i.e. their actual and regular use by the population;

Considering that surveyed population are already using the net for “mosquito protection” and put a special emphasis on babies protection.

6.1 We Recommend

The Realization of regularly done KAP surveys for monitoring the national program based on large scale distribution of LLIN; along with regular insecticide resistance test on main mosquitoes species (not only malaria vectors).

The Realization of other such KAP surveys in other town and regions to gain reliable information on actual behaviour of communities and to prepare adapted IEC message which could be different according to social, cultural etc diversity of the country.

The Realization of training session at regional level to gain reliable data in closed countries, for example close to the border and to prepare IEC messages and monitoring operations to check the eventual change of behaviour with communication program.

CONSENT

As per international standard or university standard, respondents’ written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

These surveys, and analysis, are a part of the comprehensive epidemiological study, involving vector control, done at the request, and in permanent cooperation, with the Angola National Malaria Control Program and Provincial Public Health Authorities., Ministry of Health.

ACKNOWLEDGEMENTS

We would like to thank the manager of the Angolan company Sonamet and its medical department; as well as the international company SubSea7 for their permanent support for this work and their implication in malaria control in the region.

Our thanks also to the national and provincial public health authorities for their authorization and participation in these studies.
COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Consultoria de Serviços, Estudos e Pesquisas COSEP.; Inquérito de Indicadores da Malária em Angola 2006/2007. Luanda -Angola:. Consultoria de Serviços, Estudos e Pesquisas - COSEP Ltda, Consultadoria de Gestão e Administração em Saúde - Consaúde Ltda, Macro International Inc; 2007.

2. Fançony C, Sebastião Y, Pires J, Gamboa D, Nery S: Performance of microscopy and RDTs in the context of a malaria prevalence survey in Angola: a comparison using PCR as the gold standard. Malar J. 2013;12:284.

3. Lopes S, Mugizi R, Pires J, David F, Martins J, Dimbu P, Fortes F, Rosário J, Allan R: Malaria Test, Treat and Track policy implementation in Angola: a retrospective study to assess the progress achieved after 4 years of programme implementation. Malar J. 2020;19:262.

4. Plucinski M, Ferreira M, Ferreira C, Burns J, PG, Lubaki J, da Costa O, Gill P, Samutondo C, Quvinja J, et al: Evaluating malaria case management at public health facilities in two provinces in Angola. Malar J. 2017;16:186.

5. Somandjinga M, Lluberas M, Jobin W: Difficulties in organizing first indoor spray programme against malaria in Angola under the President's Malaria Initiative. Bull World Health Organ. 2009;87:871-874.

6. Hemingway J, Field L, Vontas J: An overview of insecticide resistance. Science Washington. 2002;298:96-97.

7. Ranson H, N’guessan R, Lines J, Moiroux N, Nkuni Z, Corbel V: Pyrethroid resistance in African anopheline mosquitoes: what are the implications for malaria control? Trends Parasitol. 2011; 27:91-98.

8. N’Guessan R, Corbel V, Akogbeto M, Rowland M: Reduced efficacy of insecticide-treated nets and indoor residual spraying for malaria control in pyrethroid resistance area, Benin. Emerg Infect Dis. 2007;13:199 - 206.

9. Lengeler C, Snow R: From efficacy to effectiveness: insecticide-treated bednets in Africa. Bull World Health Organ. 1996; 74:325-332.

10. Koekner H, Yukich J, Mkindi A, Mandike R, Brown N, Kilian A, Lengeler C: Analysing and recommending options for maintaining universal coverage with long-lasting insecticidal nets: the case of Tanzania in 2011. Malar J. 2013;12:50. DOI: 10.1186/1475-2875-1112-1150.

11. Abate A, Degarege A, Erko B: Community knowledge, attitude and practice about malaria in a low endemic setting of Shewa Robit Town, northeastern Ethiopia. BMC Public Health. 2013;13:312.

12. Astatkie A: Knowledge and practice of malaria prevention methods among residents of Arba Minch Town and Arba Minch Zuria District, Southern Ethiopia. Ethiop J Health Sci. 2010;20:185.

13. Deressa W, Ali A, Enquoselassie F: Knowledge, attitude and practice about malaria, mosquito and antimalarial drugs in rural community. Ethiop J Health Dev. 2003;17:99.

14. Legesse M, Deressa W: Community awareness about malaria, its treatment and mosquito vector in rural highlands of central Ethiopia. Ethiop J Health Dev. 2009;23:40.

15. Tilaye T, Deressa W: Community perceptions and practices about urban malaria prevention and control in Gondar Town, northwest Ethiopia. Ethiop Med J. 2007;45:343-351.

16. Zerdo Z, Bastiaens H, Anthierens S, Massebo F, Masne M, Bireshaw G, Shewangizaw M, Tunje A, Chisha Y, Yohannes T, Van Geertruyden J: Long-lasting insecticide-treated bed net ownership, utilization and associated factors among school-age children in Dara Mallo and Uba Debretehaye districts, Southern Ethiopia. Malar J. 2020;19:369.

17. Safari M, Fabian M, Joseph R, Soori E, Godfrey M, Robert M, Coleman K, Stephen M, Leonard E: Knowledge, attitudes and practices about malaria among communities: Comparing epidemic and non-epidemicprone communities of Muleba district, North-western Tanzania. BMC Public Health. 2010;10:395.

18. Njau J, Stephenson R, Menon M, Kachur S, McFarland D: Exploring the impact of targeted distribution of free bed nets on households bed net ownership, socio-economic disparities and childhood malaria infection rates: analysis of national
malaria survey data from three sub-Saharan Africa countries. Malar J. 2013; 12:245.

19. Tsuang A, Lines J, Hanson K: Which family members use the best nets? An analysis of the condition of mosquito nets and their distribution within households in Tanzania. Malar J. 2010;9:211.

20. Mboma Z, Overgaard H, Moore S, Bradley J, Moore J, Massue D, Kramer K, Lines J, Lorenz L: Mosquito net coverage in years between mass distributions: a case study of Tanzania, 2013. Malar J. 2018;17:100.

21. Salwa M, El-Amin E, Hayder A, Abd El-Karim A: Knowledge, practices and perceptions which affect acquiring malaria in man-made malarious area in Khartoum State, Sudan. Sudanese J Public Health. 2009;4:199.

22. Hlongwana K, Mabaso M, Kunene S, Govender D, Maharaj R: Community knowledge, attitudes and practices (KAP) on malaria in Swaziland: a country earmarked for malaria elimination. Malar J. 2009;8. DOI: 10.1186/1475-2875-1188-1129.

23. Khumbulani W, Musawenkosi L, Simon K, Dayanandan G, Rajendra M: Community knowledge, attitudes and practices (KAP) on malaria in Swaziland: A country earmarked for malaria elimination. Malar J. 2009;8:29.

24. Adedotun A, Morenikeyi O, Odaibo A: Knowledge, attitudes and practices about malaria in an urban community in Southwestern Nigeria. J Vect Born Dis. 2010;47:155.

25. Erhun W, Agbani E, Adesanya S: Malaria Prevention: Knowledge, attitude and practice in a Southwestern Nigerian community. Afr J Biomed Res. 2005;8:25.

26. Onwujekwe O, Akpala C, Ghasi S, Shu E, Okonkwo P: How do rural households perceive and prioritise malaria and mosquito nets? A study in five communities of Nigeria. Public Health. 2000;114:407-410.

27. Okrah J, Traoré C, Palé A, Sommerfeld J, Müller O: Community factors associated with malaria prevention by mosquito nets: an exploratory study in rural Burkina Faso. Trop Med Int Health. 2002;7:240-248.

28. Desfontaine M, Gelas H, Cabon H, Goghomou A, Kouka Bembda D, Carnevale P: [Evaluation of practice and costs of vector control on a family level in Central Africa. II. Douala City (Cameroon), July 1988]. AnnSoc belge Med trop. 1990; 70:137-144.

29. Desfontaine M, Gelas H, Kouka Bembda D, Goghomou A, Carnevale P: [Evaluation of practices and costs of antivectorial control at the family level in central Africa, I. Yaoundé City (March 1988)]. Bull soc path exot. 1989;82:558-565.

30. Teh R, Sumbele I, Meduke D, Nkeudem G, Ojong S, Teh E, Kimbi H: Insecticide-treated net ownership, utilization and knowledge of malaria in children residing in Batoke-Limbe, Mount Cameroon area: effect on malario-metric and haematological indices. Malar J. 2021; 20:333.

31. Wanzira H, Yeka A, Kigozi R, Rubahika D, Nasr S, Sserwanga A, Kamya M, Filler S, Dorsey G, Steinhardt L: Long-lasting insecticide-treated bed net ownership and use among children under five years of age following a targeted distribution in central Uganda. Malar J. 2014;13:185.

32. Andinda M, Mulogo E, Turyakira E, Batwala V: Predictors of sleeping under cost-free mosquito bed nets among children under-five years in Mbarara, Uganda: a household survey. Afr Health Sc. 2019;19:1353-1360.

33. Moscibrodzki P, Doble M, Stone J, Kalumuna C, Chiu Y, Hennig N: Free versus purchased mosquito net ownership and use in Budondo sub-county, Uganda. Malar J. 2018;17:363.

34. Drame P, Poinssignon A, Besnard P, Le Mire J, Dos-Santos M, Sow C, Cornelie S, Foumane V, Toto J, Sembène M, et al: Human Antibody Response to Anopheles gambiae Saliva: An Immunological Biomarker to Evaluate the Efficacy of Insecticide-Treated Nets in Malaria Vector Control. Am J Trop Med Hyg. 2010;83:115-121.

35. Drame P, Poinssignon A, Besnard P, Cornelie S, Le Mire J, Toto J, Foumane V, Dos-Santos M, Sembène M, Fortes F, et al: Human antibody responses to the Anopheles salivary gSG6-P1 peptide: a novel tool for evaluating the efficacy of ITNs in malaria vector control. PlOSe One. 2010;5:e15596.

36. Carnevale P, Foumane Ngane V, Toto J, Dos Santos M, Fortes F, Manguin S: The Balombo (Benguela Province, Angola) Project: a village scale malaria vector control programme with a long term comprehensive evaluation. 6th PAMCA
Annual Conference and Exhibition Strengthening surveillance systems for vector-borne disease elimination in Africa Yaoundé 23-25 septembre. 2019:20-23.

37. Brossseau L, Drame P, Besnard P, Toto J, Foumame V, Le Mire J, Mouchet F, Remoue F, Allan R, Fortes F, et al: Human antibody response to Anopheles salivara for comparing the efficacy of three malaria vector control methods in Balombo, Angola. PLoS One. 2012; 7:e44189.

38. Carnevale P, Toto J, Besnard P, Santos M, Fortes F, Allan R, Manguin S: Spatiotemporal variations of Anopheles coluzzii and An. gambiae and their Plasmodium infectivity rates in Lobito, Angola. J Vector Ecol. 2015;40:172-179.

39. Carnevale, G., Carnevale P: A New, Cheap, Easy to Use, Foldable and Portable Autocidal Ovitraps for Aedes Control at Community Level. Asian Journal of Research in Infectious Diseases. 2021; 6:9-28.

40. Toto J, Besnard P, Le Mire J, Almeida D, Dos Santos M, Fortes F, Foumame V, Simard F, Awono-Ambene H, Carnevale P: Preliminary evaluation of the insecticide susceptibility in Anopheles gambiae and Culex quinquefasciatus from Lobito (Angola), using WHO standard assay. Bull Soc Pathol Exot. 2011; 104:307-312.

41. Besnard P, Foumame V, Le Mire J, Foucher JF, Chilombo M, Fortes F, Carnevale P: Overnotification of malaria, exemple in consultations in Health Center of Lobito, Angola]. Sci Med Afr. 2009;1:53-59.

42. Manguin S, Foumame V, Besnard P, Fortes F, Carnevale P: Malaria overdiagnosis and subsequent overconsumption of antimalarial drugs in Angola: Consequences and effects on human health. Acta Trop. 2017;171:58-63.

43. Besnard P, Foumame V, Foucher J-F, Beliaud P, Costa J, Monnot N, LeMire J, Carnevale P: Impact of a new parasitological laboratory for malaria diagnosis on diagnosis and cost of malaria in a company setting: experience from Angola]. Méd Trop. 2008; 66:269-272.

44. Carnevale P, Toto, JC, Foumame V, Carnevale S, Gay F: Co-Evolution of the Presence of Long Lasting Insecticide Treated Nets and Plasmodium falciparum Welch, 1897 Prevalence in Cahata Village (Benguela Province, Angola) during a Village Scale Long-Term of Malaria Vector Control Program. Asian J Res Inf Dis. 2021;7:21-32.

45. Manga L, Robert V, Carnevale P: Effectiveness of coils and mats for protection against malaria vectors in Cameroon. Santé. 1995;5:85-88.

46. Chouakeu N, Ngingahì L, Bamou R, Talipouo A, Ngadjue C, Mayi M, Kopya E, Awono-Ambene P, Tchuinkam T, Nkondjio C: Knowledge, Attitude, and Practices (KAP) of Human Populations towards Malaria Control in Four Ecoepidemiological Settings in Cameroon. J Trop Med; 2021.

47. Stephens C, Masamu E, Kiama M, Kato A, Kinenekejo M, Ichimori K, Lines J: Knowledge of mosquitoes in relation to public and domestic control activities in the cities of Dar es Salaam and Tanga. Bull Wld Hlth Org. 1995;73:97-104.

48. Louis J, Trebucq A, Galas H, et al. [Malaria in Yaoundé (Cameroon). Cost and antivectorial control at the family level]. Bull Soc Path Exot. 1990;85:26-30.

49. Ziba C, Slutsker L, Chitsulo L, Steketee R: Use of malaria prevention measures in Malawian households. Trop Med Parasitol. 1994;45:70-73.

50. Tomass Z, Alemayehu B, Balkew M, Leja D: Knowledge, attitudes and practice of communities of Wolaita, southern Ethiopia about long-lasting insecticidal nets and evaluation of net fabric integrity and insecticidal activity. Parasit Vectors. 2016;9:224.

51. Miller J, Korenromp E, Nahlen B, Steketee R: Estimating the number of insecticide-treated nets required by African households to reach continent-wide malaria coverage targets. JAMA. 2007; 297:2241-2250.

52. WHO. Conditions for deployment of mosquito nets treated with pyrethroid and piperonyl butoxide. Geneva: World Health Organization Global Malaria Programme; 2017.

53. Skovmand O: Comparing the un-comparable: Olyset Plus and Olyset, different malaria impact. Malar J. 2018; 17:446.

54. Gunasekaran K, Sahu S, Vijayakumar T, Subramanian S, Yadav R, Pigeon O, Jambulingam P: An experimental hut evaluation of Olyset® Plus, a long-lasting insecticidal net treated with a mixture of permethrin and piperonyl butoxide, against
Anopheles fluviatilis in Odisha State, India. Malar J. 2016;15:375.

55. Pennetier C, Bouraima A, Chandre F, Plameu M, Etang J, Rossignol M, Sidick I, Zogo B, Lacroix M, Yadav R, et al: Efficacy of Olyset® Plus, a new long-lasting insecticidal net incorporating permethrin and piperonyl-butoxide against multi-resistant malaria vectors. PLoS One. 2013;8:e75134.

56. Corbel V, Akogbeto M, Damien G, Djenontin A, Chandre F, Rogier C, Moiroux N, Chabi J, Banganna B, Padonou G, Henry M: Combination of malaria vector control interventions in pyrethroid resistance area in Benin: a cluster randomised controlled trial. Lancet Infect Dis. 2012;12:617-626.

57. Protopopoff N, Mosha J, Lukole E, Charlwood J, Wright A, Mwalim C, et al. Effectiveness of a long-lasting piperonyl butoxide-treated insecticidal net and indoor residual spray interventions, separately and together, against malaria transmitted by pyrethroid-resistant mosquitoes: A cluster, randomised controlled, two-by-two factorial design trial. Lancet. 2018, 391:15788.

58. DePina A, Dia A, de Ascençao Soares Martins A, Ferreira M, Moreira A, Leal S, Pires C, Moreira J, Tavares M, da Moura A, et al: Knowledge, attitudes and practices about malaria in Cabo Verde: a country in the pre-elimination context. BMC Public Health. 2019;19:850.

59. WHO. World malaria report. Geneva, Switzerland; 2012.

60. Abdou T, Ngadjeu CB, Doumbe B, et al. Malaria prevention in the city of Yaoundé: knowledge and practices of urban dwellers. Malar J. 2019;18:1-13.

61. Leger Offono Enama M, Akono Ntonga P, Mbida Mbida A, et al. [Malaria: knowledge, attitudes and practices in West Cameroon]. Journal of Applied Biosciences. 2020;147:15117-15124.

62. Henry Yandai F, Moundine K, Djoumbe E, et al.: [Perception of malaria risks and use of mosquito nets in Chad]. International Journal of Biological and Chemical Sciences. 2017;11.