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Use and effectiveness of commercial flit-spray insecticides in control of mosquito population in Sagamu, Southwest Nigeria

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Abstract

Introduction: Control of mosquito vector is crucial to reducing the burden of malaria in endemic region. In the present study, we investigated the use of commercial insecticides in families and their effectiveness in control of mosquito population in Sagamu, southwest Nigeria.
Materials and methods: A pretested structured questionnaire was used to determine mosquito adulticides techniques employed in the community and most commonly used adulticides were evaluated for effectiveness by exposing adult mosquitoes to varying concentrations of the insecticides and responses monitored.
Results: Families differ in methods adopted to prevent mosquito and use of flit-spray insecticide was commoner. Although parents constitute 64% of those applying the insecticide, 22.2% were children. Household pyrethroid insecticide products of Baygon® (Imiprothrin, Prallethrin plus Cyfluthrin), Mobil® (Neopynamin, Prallethrin plus Cyphenothrin) and Raid® (Pynamin forte, Neopynamin plus Deltimethrin) were three commonly used in the community. The exposure tie interval for eath of osquitoes was shorter with Raid® (100% at 8 minutes) when compared with Mobil (80%) and Baygon (85%) at 10 minutes (p= 0.005). Kaplan-Meier survival curve of cumulative probability of surviving exposure to insecticide was lowest with Raid® (log rank ^{2} = 14.56, P= 0.001).
Conclusion: Although flit-spray insecticides are affordable with simple application tool, inexplicit use-instruction on labels may cause discrepancies in application. Monitoring responses of mosquitoes to commercial flit-spray insecticide may support effective control technique and prevention of vector resistance in poor resource communities.

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Keywords: *Malaria, flit-spray insecticides, mosquito, control, endemic area*

Résumé

Introduction: Contrôle des moustiques vecteurs est essentielle pour réduire la charge du paludisme dans la région endémique. Dans la présente étude, nous avons enquêté sur l'utilisation d'insecticides commerciaux dans les familles et de leur efficacité dans le contrôle de la population de moustiques à Sagamu, dans le sud-ouest du Nigeria.
Matériaux et méthodes: Un questionnaire pré-testé structuré a été utilisé pour déterminer les techniques d'insecticides destinés aux moustiques adultes employées dans la collectivité et les plus couramment utilisés ont été évalués pour l'efficacité en exposant les moustiques adultes à des concentrations variables des insecticides et des résultats suivis de prêt.
Résultats: Les familles diffèrent dans les méthodes adoptées pour prévenir les moustiques et l'utilisation de pulvérisés était de routine. Bien que les parents constituent 64% de ceux qui appliquent les insecticides, 22,2% étaient des enfants. Les produits des insecticides pyréthrinoïdes de Baygon (imiprothrine, Prallethrin ainsi cyfluthrine), Mobil ® (Neopynamin, prallethrine ainsi cyphénothrine) et Raid ® (Pynamin forte, plus les Neopynamin Deltimethrin) sur les objets ménagers étaient les trois couramment utilisé dans la communauté. Le taux de mortalité des moustiques exposés était plus courte avec Raid ® (100% à 8 minutes) comparé à Mobil (80%) et Baygon (85%) à 10 minutes (P = 0,005). La courbe de survivance de Kaplan-Meier de la probabilité cumulée d'exposition de résistance aux insecticide était le plus bas avec Raid ® (log rank 2 = 14,56, P = 0,001).
Conclusion: Bien que le prix de pulvérisant soient abordables avec un outil d'utilisation simple, des instructions peu explicites de leur utilisation sur les étiquettes peuvent causer des écarts dans l'application. Des résistances suivies des moustiques à voltiger aux insecticides pulvérisés commercialisés

formal training on how to apply, and how much of insecticide is needed per square feet or meter of their rooms. Three hundred and sixty nine (92%) of the respondents reported that neither they nor their husbands had read the instructions on use of the insecticide, affix to the flit spray insecticide container.

A total of 600 mosquitoes were bred in the laboratory and exposed to the three most common commercial insecticides used in the community. Table 2 showed the mortality resulting at different exposure times in a defined area and at a given concentration. A significant median value of 100% mortality was achieved at the shortest exposure time of 8 minutes with Raid® compared with Mobil® (70%) and Baygon® (80%) at same time. In addition Raid® combination of antivectors proved significantly more effective than Mobil® and Baygon® composition at 2, 4, 6, 8 and 10 minutes ETs respectively. The probability of mosquitoes surviving an insecticide when exposed to these insecticides is presented in a Kaplan Meier survival plot (Figure 1). Mosquitoes exposed to Raid had® the least probability of survival.

Table 1: The distribution of commercial insecticides used in the households during the period of assessment

Products	Number of Users	Proportion (%)
Baygon®	88	22.0
Mobil®	36	9.0
Raid®	117	29.2
Texaco®	1	0.2
Klit®	7	1.7
Coils plus any liquid insecticide	80	20.0
Kerosene	1	0.2
Bark of Plants and fruit	71	17.7

water bodies in the different locations in Sagamu (gutters, old tires, pots) into sterile containers and taken into the laboratory. A Pasteur pipette was used to transfer the larvae and pupae into a beaker containing well water. 70%w/v glucose solution was prepared into 50cl water for the development of the larvae and pupae. The bowl was then kept in a well ventilated insectary used for breeding in the laboratory. The emerging adult mosquitoes were provided access to 70% glucose for 3-5 days by soaking balls of cotton wool in the glucose solution and placing it in the insectary for the emerged adults to feed on before being used for the experiment.

Assessment of effectiveness of the flit-spray insecticides

The experiment was carried out in five replicates with five transparent plastic cages for each of the graded volumes of insecticide used (0.2ml, 0.5ml, 1ml and 2ml). The three most commonly used insecticides that were found out from the outcome of the questionnaire were used in the experiment. A putter was used to collect ten (10) mosquitoes from the breeding insectary into each of the cages. A control experiment was set up for each exposure of mosquitoes.

A 2ml syringe was used to measure the varying volumes of insecticides used for the experiment. The insecticides were then sprayed evenly into the cages with the use of the (2ml) syringe modified to produce dewdrop and the cages air-locked to prevent the escape of the insecticides. The stopwatch was used to monitor the time (minutes) of exposure and observations were made within a period of ten (10) minutes. The number of dead, active (flying) and inactive mosquitoes (weakened) at intervals of two (2) minutes i.e. 0, 2, 4, 6, and 10 minutes, respectively, were recorded.

After ten minutes, life mosquitoes were allowed to stay for extra thirty (30) minutes and those that did not die were killed and kept for further analysis.

Statistical analysis

Data were analysed using version 6 of the Epi-Info software [6], and the statistical program SPSS for Windows version 14.0 [7]. Normally distributed, continuous data were compared by Student's t-tests and analysis of variance (ANOVA). Data not conforming to a normal distribution were compared by the Mann-Whitney U-test and the Kruskal-Wallis test (or by Wilcoxon rank sum test). The association between two continuous variables was assessed by Spearman's rank correlation coefficient. Differences in survival time were assessed by the inspection of Kaplan-Meier curves and log-rank tests. All tests of significance were two-tailed. P-values $\leq$ 0.05 were taken to indicate significant differences.

Results

Between August and October 2008, a total of 401 households were enrolled into the insecticide use assessment study. The mean age of the women enrolled in the study was 32 $\pm$ 3.5 years (range= 18-45 years). Most participants live in rented apartments with 259;(64.6%) in 'standing alone' apartments and 142 (35.4%) in single or double room sublets.

The educational level of the participants as a measure of level of literacy shows that 38.1% (153) had first or higher degrees, 56.1% (185) had primary, secondary or diploma certificates, while 15.8% (63) had no formal education.

Table 1 shows the pattern of use of different insecticide for mosquitoes control in the households investigated. Two hundred and forty nine (62.1%) households used flit-spray insecticides commercially available in the communities. Other forms of insecticide reported used were insecticide coils 71, kerosene 80, and bark of local plants and fruit 1, respectively. The three major commercial insecticides that were frequently used by the households were identified as Raid® (Pynamin forte- 0.05%, Neopynamin- 0.05%, Deltimethrin- 0.015%), Baygon®(Imiprothrin- 0.05%, Prallethrin- 0.05%, Cyfluthrin- 0.015%), and Mobil® (Neopynamin- 0.25%, Prallethrin- 0.04%, Cyphenothrin- 0.05%).

The assessment of frequency of application of insecticides in the homes showed that 110 of 401 (27.4%) applied insecticides to their apartment daily. In the remaining households, 198 (49.4%), 85 (21.2%) and 4 (1.0%) claimed to apply the insecticides weekly, biweekly, and monthly respectively. The assessment of influence of formal education of participants in determining the frequency of use of the insecticides per household showed that 42 of 62 (67.7%) with no formal education and 224 of 314 (71.3%) with formal education did not apply insecticides to homes daily. There was no significant difference in the proportions (Yate's corrected ^{2} = 0.17, P= 0.67). No use of insect treated bed nets was also reported in these homes.

In most households, house heads [120 fathers (29.9%) and 138 mothers (34.7%) were reported to constitute the individuals that apply the insecticides. However, 22.2% (89) of the houses claimed their children could apply the insecticide to homes. None of the participants have had a

Discussion

The control of mosquitoes by the use of insecticides will reduce the burden of malaria. Scientific evidence indicates that IRS is effective to control malaria transmission and thus reduce the related burden of morbidity and mortality as long as most premises (houses, animal shelters) (e.g. > 80%) within targeted communities are treated [4]. This study has identified that due to lack of adequate commitment to malaria control and absence of IRS programme in the study community, households have resorted to using flit-spray insecticide and other adulticides for mosquito control, including use of barks of plants and fruits. The three major commercial insecticides used in this community are made up of combinations of different types of pyrethroids at different concentrations - Raid®, Baygon® and Mobil®. This buttress the fact that there is increasing use of pyrethroids and, to a lesser extent, organophosphates and carbamates for malaria vector control in endemic countries [8]; oftentimes unregulated or unsupervised.

The frequency of use of the commercial insecticides by the participants in this study differs greatly with more than half of the population (51.4%) on weekly application. The educational status of the respondents has no significant impact on the frequency of use of the insecticide suggesting that those that are educated do not have extended advantage over others in respect of adequate knowledge on the appropriate use of the insecticides. It is surprising to note that children are also engaged by their mothers to flit spray the rooms. This attitude indicates low knowledge on the potential danger associated with exposing children to insecticide and possible misuse. The inconsistency in the use of insecticides can confer resistance on the mosquitoes and further contribute to the challenges of reducing malaria transmission. The development and spread of insecticide resistance are dependent on the volume and frequency of application of insecticides and the inherent characteristics of the malaria vectors against which they are used [9,10]. Therefore there may be need to standardize the application of the flit-sprays in the area of study.

Furthermore, the expected awareness to be provided by the use-instructions on labels of the commercial flit-spray is compromised as none of the participant took time to read. The reason(s) for this is (are) not clear from the present study but may be due to general lackadaisical attitude from the people or poor communication from manufacturers.

In the second part of the study that investigates effectiveness of different concentrations of insecticide needed under a defined area, a 100% mortality was achieved with Raid® at the shortest exposure time of 8 minutes compared with Mobil® (80%) and Baygon® (85%) at the exposure time of 10 minutes each. There was no mortality in all the control set-up during the experiments. The Kaplan Meier survival plot shows that mosquitoes exposed to Raid® had the least probability of survival. These results indicate that the Raid® insecticide is the most effective of the three most commonly used insecticides in Sagamu community.

The findings in this study suggest that, though the flit-spray insecticides are available and ready alternative to IRS in poor endemic areas;, irregular use in the homes and ineffectiveness of insecticides may arise from a range of factors. These may include low level of awareness of use of the flit spray insecticide or inadequate cognisance to read the instructions on the label and understand the frequency of use of the insecticides. In addition, the challenges of inadequate instructions on the label of the insecticides on the actual concentration or dose that will be effective on mosquito population per square feet or meter of a room, low income to sustain regular purchase of the insecticides, lack of experience on the use of the insecticide and cautions, and poor application, in case of children flit spraying the homes, may be contributory. All these may result in poor malaria control situation and outcomes in severely affected areas where otherwise the effective control of mosquito populations is plausible.

Conclusively, lack of adequate knowledge and proper attitude in communities where individuals are responsible for providing alternative mosquito control strategy to prevent malaria attack may impair control efforts and increase spread of resistance. Although flit-spray insecticides are affordable with simple application tool, inexplicit use-instruction on labels may cause discrepancies in application. In communities with yet established functional mosquito control agencies, campaign on appropriate use of flit spray insecticide, provision of legible instruction by manufacturers and regular evaluation of the available commercial insecticides for effectiveness against mosquito population in such areas will enhance protection and support malaria control efforts.

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Table 2: The percentage mortality resulting at different time intervals of exposure (ET) of mosquito population to common insecticide used in households in the study

Parameters	Baygon®	Mobil®	Raid®	P value
ET_{2min}				
Mean (SD)	43.1 (27)	28.7 (16.3)	56(16.6)	0.002
range	0-80	0-50	30-80	
Median	50.0	30.0	60	
ET_{4min}				
Mean (SD)	56.2(28)	44.3 (17.1)	71.8(17.9)	0.003
range	20-100	20-70	40-100	
Median	60.0	50.0	70	
ET_{6min}				
Mean (SD)	62.5 (29.3)	58.7(21.5)	81.8(15.1)	0.013
range	20-100	20-90	50-100	
Median	70.0	60.0	85	
ET_{8min}				
Mean (SD)	71.2 (25.5)	71.2 (19.6)	92.5(12.3)	0.005
range	30-100	30-100	60-100	
Median	80.0	70.0	100	
ET_{10min}				
Mean (SD	80.6 (20.3)	80.0 (21.6)	95.6(9.6)	0.025
)range	40-100	40-100	70-100	
Median	85.0	80.0	100	

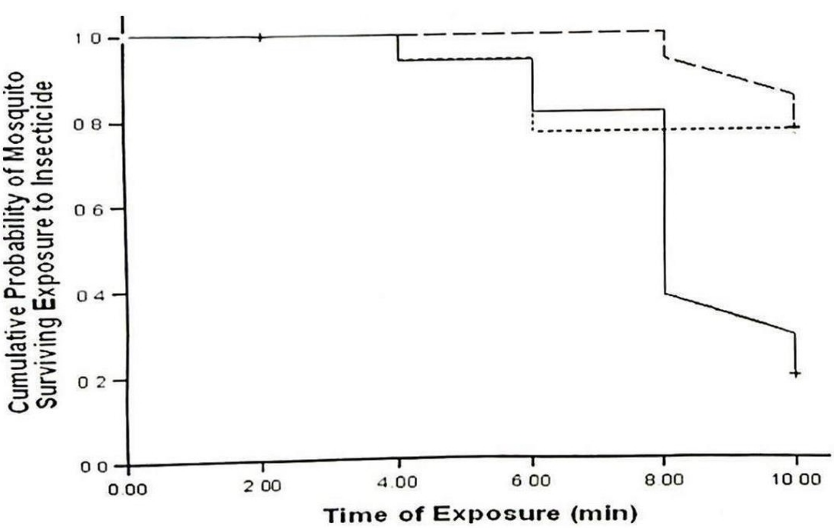

Figure 1: Kaplan Meier plot of the cumulative probability of mosquito surviving exposure to insecticides [broken thick line (--------) = Mobil®; broken dotted lines (.....)=Baygon®; unbroken lines (—) = Raid®; Log rank (Test of equality of survival distributions for the different insecticides) Chi square= 14.56, df= 2, P value = 0.001].

References

1. World Health Organization. World Malaria Report. World Health Organization, Geneva, 2008
2. Townson H, Nathan MB, Zaim M *et al*, Exploiting the potential of vector control for disease prevention. Bulletin of World Health Organization, 2005; 83(12):942-947.
3. World Health Organization. The use of DDT in malaria vector control: WHO Position Statement. World Health Organization, Geneva. 2007
4. World Health Organization. Indoor Residual Spraying: Use of Indoor Residual Spraying for Scaling Up Global Malaria Control and Elimination.Geneva: World Health Organization.2006: http://whqlibdoc.who.int/hq/2006/WHO_HTM_MAL_2006.1112_eng.pdf
5. Zaim M and Jambulingam P. Global Insecticide Use for Vector-Borne Disesae Control. World Health Organization Pesticide Evaluation Scheme (WHOPES). Geneva. 2007.
6. Anonymous. Epi Info Version 6. A Word Processing Data Base and Statistics Program for Public Health on IBM-compatible Microcomputers. Atlanta, GA: Centres for Disease Control and Prevention. 1994.
7. Anonymous. SPSS for Windows Release 10.01 (Standard Version). Chicago, IL: SPSS Inc. 2005
8. Coleman M, Sharp B, Seocharan I and Hemingway J. Developing an evidence-based decision support system for rational insecticide choice in the control of African malaria vectors. Journal of Medical Entomology 2006,;43: 663–668.
9. Hemingway J and Georghiou GP. Studies on the acetylcholinesterase of Anopheles albimanus resistant and susceptible to organophosphate and carbamate insecticides. Pesticides Biochemistry and Physiology, 1983; 19: 167-171.
10. Hemingway J, Hawkes NJ, McCarroll L and Ranson H. The molecular basis of insecticide resistance in mosquitoes. Insect Biochemistry and Molecular Biology.2004; 34: 653–665.

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in a carefully regulated water bath at 45°C to yield a black solid extract weighing 10gm. The extract was stored in the refrigerator at 4°C and dilutions made in saline for pharmacological studies as and at when due.

Formalin-induced paw licking in rats
This test was carried out as previously described [7]. The extract, at doses of 300, 400 and 500mg/kg was administered per oral (p o.) to the rats in the different groups . One hour later , 20 μL of 1% formalin was injected into the dorsal surface of the left hind paw of the rats. Control animals received normal saline (10ml/kg, p o) and indomethacin (10mg/kg, p o) was given to the reference group. The animals were observed in a glass chamber with a mirror mounted on three sides for an unobstructed view of the paws. The time spent in licking the injected paws (licking time) was noted. They were observed for the first 5 min post formalin (early phase) and for 10 min starting at the 20th min post formalin injection (late phase).

Acetic acid–induced writhing in mice
This test was carried out using the method of Siegmund et al [8] as modified by Konster et al [9]. The extract at doses of 300, 400 and 500mg/kg was administered to mice pre-fasted for 16hr in three different groups. One hour after treatment, the mice were given an intraperitoneal injection of 0.2ml of 3 percent acetic acid solution to induce the characteristic writhing. The number of writhings occurring between 5 and 10 min post injection was recorded. The response of the extract and the indomethacin (10mg/kg) treated groups were compared with those in the control group.

Hot plate test
The hot plate test was carried out using the method of Eddy and Leimback [10] as modified by Ibironke et al [11]. Using this method, rats in the experimental groups were given 300, 400 and 500 mg/kg of the extract after a 12hr fast. The rats in the control and reference groups were given normal saline (10ml/kg) and indomethacin (10mg/kg) respectively after the fast.

The rats were then placed in turn on the hot plate 30min after the administration of the drug, extract, reference drug or normal saline. The time taken for the animals to start licking the paws or jump off the plate was noted and taken as the hot plate latency. The test was carried out at the beginning of the experiment (base line) and at 30, 60 and 90min after the administration. At no time was any animal allowed to stay on the hot plate for more than 60 seconds in order to prevent excessive tissue damage. The mean hot plate latency for each group was determined. The hot plate temperature was set 55 ± 2°C.

Carrageenan-induced paw edema in rats
Edema was induced by injecting 0.1ml of 1 percent (w/v) carrageenan into the sub plantar region of the right hind paw of the rats according to Winter *et al* [12].

The control,experimental and the reference groups were given 10ml/kg normal saline, 300-500mg/kg of the CF extract and 10mg/kg indomethacin respectively.

Measurement of paw size was carried out by wrapping a piece of cotton thread round the paw and the length of the thread corresponding to the paw circumference determined using a meter rule according to Bamgbose and Noamesi [13]. Measurement was done immediately before and at 3hr and 5hr after carrageenan injection. The inhibitory activity was calculated according to the following formula:

Percentage inhibition=

$$\frac{(Ct - Co)\ \text{control} - (Ct - Co)\ \text{treated}}{(Ct - Co)\ \text{control}}$$

Where: Ct is the paw circumference at time t
Co is the paw circumference before injection
Ct-Co represents presence of edema.

Cotton pellet granuloma in rats
The method described by Moss *et al* [14] was employed. In this study, a sterilized dry cotton pellet weighing 30mg was introduced subcutaneously into the groin region of the rats. The animals were then subjected to the usual various daily agents as in the previous tests (hot plate , acetic acid induced writhing and formalin induced paw licking) for 4 consecutive days. At the end of this period, the animals were humanely killed with ether, the pellets removed, freed from extraneous tissue, dried overnight at 60°C and weighed.

Statistical analysis
Values were expressed as means ± SEM. Statistical analysis was by unpaired comparison using the student´s t- test. A value of $p < 0.05$ was regarded as significant.

Results

Formalin-induced paw licking in mice
The methanol extract of CF caused significant inhibition of both the early and late phases of formalin induced paw licking at 400mg/kg ($p<0.05$) and 500mg/kg ($p<0.001$) dose levels compared with the control. While the inhibition at the 300mg/kg dose