IMPACT OF ATTITUDE AND KNOWLEDGE OF INSECTICIDE SAFETY

HOUSEHOLD AND SPRAY-MEN ON GAMBIAE CONTROL

PROJECT AREA NORTHERN STATE, SUDAN

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ABSTRACT

This study aimed to evaluate community acceptance and safe use of insecticides by spray-men in the Gambiae Control Project Area at Sudan. Two types of surveys were carried out the household survey and spray-men interviews after obtaining informed consent to participate in the study at the gambiae control project. Five hundred household interviewed, only 21 have been reported a malaria case. About 60% of the household identified the mosquitoes' peak density between March-May. Overall, 93% of the household indicated that indoor residual spray is a useful measure for malaria prevention; and 93.4% accept Gambiae Control Project Area is a successful programme against malaria. However, 52% of the respondents clarified that wall painting is a periodical habit before Eid. On the other hand, 86.7% spray-men identified the sources of mosquitoes breeding sites were water pipe breaks, leakages of irrigation canals and a well. Moreover, 72.4% of spray-men reported the peak season of Anopheles to extend from March to June. Almost all of the spray-men (96.4%) said they would burn insecticides bottles after work. Following the above findings, administrative as well as educational interventions should be considered and arranged in order to sustain the success of the gambiae control project area

KEYWORDS: Indoor Residual Spraying, An. Arabiensis, Malaria Prevention Community, Knowledge & Perceptions

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INTRODUCTION

Malaria still causes the highest morbidity and mortality in developing countries. Most of the cases in 2016 were in the WHO African Region, followed by the WHO South-East Asia Region. Sudan recorded highest malaria morbidity within their region country, malaria prevention depending indoor residual spraying (IRS), long-lasting insecticide-treated nets (LLITNs) and larvae control (Abdelraheem, Albsheer, Mohamed, Amin, & Mahdi Abdel Hamid, 2016; WHO, 2012). Historically, IRS has reduced malaria transmission in many areas worldwide by reducing vector prevalence and disease incidence (Pluess, Tanser, Lengeler, & Sharp, 2010; WHO, 2006; Zhou, Githeko, Minakawa, & Yan, 2010). A study done by Pluess B et.al, indicates IRS reduce re-infection, incidence rate, and malaria prevalence during the wet season. The most obstacles face IRS in the Sudan insecticide resistance (Abdalla et al., 2014; Himeidan, Muzamil, Jones, & Ranson, 2011; Pluess et al., 2010).

The wide-reaching benefits of IRS in the reducing vector prevalence and disease incidence was observed for at least six months following spraying campaign, suggesting targeted IRS as an effective tool in malaria control (Muhindo et al., 2016; Zhou et al., 2010). The main vector of malaria in the northern state was *An. arabiensis* (Ageep et al., 2009).

IRS needs the active cooperation of households in preparing the houses for spraying and subsequently in maintaining the insecticide residue by refraining from re-plastering of walls (Ediau et al., 2013; Sy et al., 2015). Factors that can limit acceptability include visible insecticide residues on walls, an unpleasant odor, or skin and nasal irritation from some insecticide products (WHO, 2006). Although pesticides are developed through very strict regulation processes to function with reasonable certainty and minimal impact on human health and the environment, serious concerns have been raised about health risks resulting from occupational exposure and from residues in food and drinking water (Damalas & Eleftherohorinos, 2011). Pesticides can contaminate soil, water, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms (Damalas & Eleftherohorinos, 2011). The safety key of pesticides handling minimizes the unsafe exposure during handling of hazardous chemicals and handling of pesticides should be aware particularly spraying staff and persons living in sprayed houses (Damalas & Eleftherohorinos, 2011; Damalas, Telidis, & Thanos, 2008; Saeed et al., 2017).

The awareness should be a routine practice an integral part of any programme linking with the application of pesticides (Saeed et al., 2017; WHO, 2006). Although limited research has been done on the topic, studies consistently find pesticide residues in the air (Aktar, Sengupta, & Chowdhury, 2009). The cases of acute pesticide poisoning (APP) account for significant morbidity and mortality worldwide especially in developing countries (Jeyaratnam, 1990). The aim of this study is to evaluate the attitude of the residence and spray-men and safety using of insecticides in the northern state, Sudan.

MATERIAL AND METHODS

Study Area

The northern Sudan located in a Sahara zone with great fluctuation in temperatures and relative humidity. The northern state area allocated into three zones according to Gambia control Project (GCP), these zones different vector control process to red yellow and green zone by GCP. This study, carried out the red zone of the GCP area (which extends from Wadi Halfa to Wawa) along the Nile banks. This area is hyper-endemic malaria, the main vector is *An. arabiensis* and malaria transmission peak is starting after the Nile flooding from September to December The population protects by GCP is about 100,000 persons. (Ageep et al., 2009; Dukeen & Omer, 1986).

Methods

Surveys: Two types of surveys they carried out a cross-sectional household survey and, spray-men interviews. Using the simple random sampling technique, two pre-designed and pre-tested questionnaires were being administered to obtain the data from households and spray-men after obtaining informed consent to participate in the study.

Sample Size

The sample size was calculated using the formula: $n = [DEFF * Np (1-p)] / [(d^2/Z^2_{1-\alpha/2} * (N-1) + p*(1-p)]$ where: n = sample size; $deff$ = design effect; N = population size; p = estimated proportion; $q=1-p$; d = absolute level of precision.

The significant differences at 95% confidence level.

Household Survey

Two trained interviewers administered questionnaires to one member of each family who indicated having good knowledge of the family and agreed interviewed.

Spray-men survey

Two types of questionnaires were differentially administered, the IRS questionnaire only confined to the spray-men who participate in the IRS campaign. On the other hand, the target group of a Larviciding questionnaire composed of Sudanese spray-men (n= 40).

RESULTS

Household Survey

Five hundred households were interviewed at Abri town and 16 villages in the red zone, about 31% (n=155) of the households reported an infrequent residency of at least one of their family members “Table 1”.

Table 1: Demographic Data Listed by the Interviewees of the Households

Criteria	N	Mean	Median	95% C.I.	Max.	Min.
Family size	500	5.12	5	4.90-5.33	17	0
No. Non-residents	Yes = 155	2.09	-	1.84-2.35	8	1
Month Family gathering	126	-	June	-		

Only eighteen households have reported a malaria incidence encountered in their families “Table 2”. In general, the peak of nuisance flies extends from January- June, and about 60% of the households identified the period extending from October-May as the high-density peak of mosquitoes) “Figure 1”.

Figure 1: Peak Months of Nuisance Flies Indexed By Households at the GCP Area

Overall, 93% of the households indicated that IRS is a useful measure for malaria prevention; and 93.4% accept GCP is a successful programme against malaria. The households confirmed a coverage rate of 77.8% during the last IRS campaign. However, reasons of un-spraying houses varied between bypassing premise by the operator (5.4%), absence (8%) of family members, and refusal by the inhabitant (8.6%) of the total population “Table 2”.

Although, about 10% of the households confirmed the presence of chronic allergic cases among their families, comparison among the refused group revealed this factor is not significant ($\chi^2=0.692$; $df=1$; $P=0.405$), “Table 2”. Types of allergy varied between Asthma (4.4%), conjunctivitis (1.4%), and dermatitis (1%). Only 1.8% of the interviewees reported side effect of IRS in these patients.

While 52% of the respondents clarified that wall painting are a habitual practice before “El Eid” (i.e. Muslim holiday), only 4.4% thought IRS could affect the painting of the room surfaces, among the latter group, peoples clean or re-plaster the walls “Table 2”.

Spray-Men (SM) survey

About 30 sprays men interviewed out of forty staffed in the GCP. The average age of the spray-men in the GCP is 40 years. No illiteracy and about two-thirds (67%) of the spray-men had an education above the primary school. In addition, two-thirds of the SM have more than 4 years working experience in the GCP.

The SM identified four main breeding sources of mosquitoes: breaks of water pipelines (93.3%); wells inside farms (93.3%); irrigation canals (80%), representing all about 86.7% of the total BS; “Figure 2”.

Figure 2: Main Sources of Breeding Sites Identified by Larviciding Spray-Men at the GCP Area

However, ditches and pools resulted from the receding of river Nile were the least source (10%). About 76.7% of the SM said they are daily Larviciding a geographical area of (1-7) kilometers, and 66.7% of the spray-men cover their proposed areas four times per month. A 40% of the spray-men covered (1-35) potential and positive BS on the last workday. About 76.7% of the spray-men explored positive BS where densities >one (3-10) on the last workday. However, 72.4% of the SM reported the peak season of *Anopheles* mosquito to extend from March to June, while 50% of the SM identified peak season of positive BS of *Culex* mosquito to extend from April to July, and the peak month is April. “Table. 3”

Table 3: Attitude of Safety Measure by the Experience of the Spray-Men

Attitude on Most Important Safety Measure	Years of Experience of Spray-Men			Total
	<5 years	(5-10) years	>10 years	
Hands washing with soap	6 (75.0%)	5 (38.5%)	3 (42.9%)	14 (50.0%)
Protect face by a mask	2 (25.0%)	1 (7.7%)	3 (42.9%)	6 (21.5%)
No feeding during spraying	0 (.0%)	7 (53.8%)	0 (0.0%)	7 (25.0%)
Be opposite to wind direction	0 (0.0%)	0 (0.0%)	1 (14.3%)	1 (3.6%)
Total	8 (100.0%)	13 (100.0%)	7 (100.0%)	28 (100.0%)

All the Spray-men (SM) informed they exclusively perform all steps of the spraying process implying they have no assistants for mixing or filling the pumps. About 66.7% of the SM possesses a pumping sprayer while the use of gallon is the alternative spraying method by the remained grouped.

Interestingly, 86% of the SM were inaccurate in recognizing the application dosage of the larviciding Temephos Abate in the field. Despite the latter, three-quarters of the SM (74%) is correct in practice to add the adequate volume of water to the pump, "Table. 4"

Table 4: Dosage Rate (gm/L2) of the Larviciding Temephos Abate as Defined by Spray-Men Cross Tabulated by the Number of Added Water to the Pump (Litters)

Dosage Rate of Abate (gm/L2)	No. added Water to the Pump (Litters)						Total
	.50	1.00	2.00	4.00	8.00	10.00	
Do not know	0	0	0	1	1	4	6
.50	1	0	0	1	0	1	3
1.00	0	0	0	0	1	3	4
2.00	0	0	1	0	0	1	2
3.00	0	0	0	0	0	1	1
4.00	0	0	0	0	0	1	1
10.00	0	0	0	0	0	4	4
16.00	0	1	0	0	0	0	1
30.00	0	0	0	0	0	1	1
35.00	0	0	0	0	0	4	4
Total	1	1	1	2	2	20	27

66.7% of the SM possessed no protective measures. The overall wear is the only protective clothing possessed by the remained grouped (33.3%), and only two SM reported they dressed overalls on the last workday. While the SM on their lacking of protective sets provided no obvious reason, torn and unfitting size is the reason of non-use of the latter.

All the SM reported they have encountered at least one-time side effects during their work. These ranged from respiratory exacerbation, to ENT to ocular and dermal ones, but no poisonous emergence situation occurred to any of the SM. Only four complained a respiratory exacerbation on the last workday. In addition, about 30% of the SM said they complained about the former side effects on the last workday. SM. remembers no periodical medical check-up.

Only 30% of the SM has been provided formal training on the safety measures, while ad hoc learning during the supervisory visit was the means to 63.3% of the SM. Half of the SM questioned thinks that hand washing by a detergent is the most useful measure; others identified the use of a protective mask (21%), and fasting during work (25%); and consideration of wind direction (4%). About 96 % of the SM said they would burn insecticides bottles after work. Only 42% of the SM declared they would keep remained insecticide to other workdays. There were 72% of the SM said they would return unused insecticide to their above authority after work.

DISCUSSIONS

Many parts of Sudan endemic malaria, include, northern state (Ageep et al., 2009; Elmardi et al., 2011). The knowledge and attitude of the community play an integral role in vector control and malaria preventions (Madani et al., 2017; Manana, Kuonza, Musekiwa, Mpangane, & Koekemoer, 2017; Munguambe et al., 2011). The population dynamic has risk indicator of introducing malaria pathogens, especially thirty percent of the population record infrequent residency (Chuquiyauri et al., 2012; Dakic et al., 2011). All these factors increase the risk of malaria in the northern state (Ageep et al., 2009; Mustafa et al., 2009). High acceptable of IRS programme and Low percentage unsprayed houses will

improve vector control these findings are in line with previous studies that reported the effect (Rehman et al., 2011; Tangena et al., 2013). Moreover, the lower percentages of refusal implies the current choice of using pyrethroid insecticide in IRS receive a good acceptance by the community (Messenger et al., 2012; Mutero, Schlodder, Kabatereine, & Kramer, 2012). Interestingly, the seasonality peak of nuisance mosquitoes recognized by the households (October-May) overlapped with the supportive period for the survival of Adults of *An. arabiensis*, which agree with the conclusion of Ageep and Dukeen. (Ageep et al., 2009; Dukeen & Omer, 1986). The apparent challenge face IRS in the northern state is wall painting, which occurs twice per year, to maintain the control programme in IRS campaign must consider these population habits. The applied pesticide formulation of the deltamethrin “Onchotherine TM” at the GCP area is a water-dispersible powder, to have a longer residual effect on mud walls (Mutagahywa et al., 2015; Uragayala, Kamaraju, Tiwari, Ghosh, & Valecha, 2015). However, households reported there no unpleasant deposit has been left on treated walls to refuse the IRS. In the past, Malathion had been employed in the GCP, complaints due to the negative properties of this insecticide were manifested by the community (Kaufman, Rweyemamu, Koenker, & Macha, 2012). Unexpectedly, according to this study coverage rate of the IRS was less than 80% of the community. This lower coverage rate implies lower effectiveness of the IRS in the prevention of malaria transmission. On the other hand, for Larviciding, hand-operated compression sprayers are adequate for application of liquid insecticides such as Temephos Abate to larger breeding sites. Granule and certain other solid formulations are applied directly by (protected) hand to confined breeding sites. However, no hand protection was shown by the SM during larviciding of BSs at the GCP area. Interestingly, Spray-men identified man-made BSs as the main aquatic habitat of *Anopheles* relatively compared to natural ditches and pools. Larviciding can be a useful method for malaria control, particularly in areas where breeding sites are accessible and relatively limited in number and size. The peak of a larval density of *An. arabiensis* identified by the spray-men overlaps with the non-flooding period (November-June) suitable for the resurgence of larval habitat. These agreed with Omer & Dukeen finding. (Dukeen & Omer, 1986)

The GCP should provide and ensure that SM possess and use safety protective measures. Medical check-up must be periodically done for the SM. Education and training sessions should be provided to the SM on the safe practice during the application of insecticides. Procedures to dispose used bottles and remained insecticides should be revised by the authority of GCP. In conclusion, administrative as well as educational interventions should be considered and arranged in order to sustain the success of the GCP

CONCLUSIONS

This study indicates highly percentages of acceptance of IRS and GCP by the community reveal that the benefits of GCP are still possessed by the local population despite decades of servicing. The applied pesticide formulation of the deltamethrin “Onchotherine TM” at the GCP area is a water-dispersible powder, to have a longer residual effect on mud walls. Interestingly, the seasonality peak of nuisance mosquitoes recognized by the households (October-May). According to this study coverage rate of the IRS was less than 80% of the community, due to lower effectiveness of the IRS in the prevention of malaria transmission. However, Spray-men identified fabricated BSs as the main aquatic habitat of *Anopheles* relatively compared to natural ditches and pools. Larviciding can be a useful method for malaria control, particularly in areas where breeding sites are accessible and relatively limited in number and size. In conclusion, administrative as well as educational interventions should be considered and arranged in order to sustain the success of the GCP.

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Table 2: The Attitude of Household to Indoor Residual Spray (IRS)

Variable	Frequency	Percentage
Family N=500		
Residence	350	70%
Frequent travel	150	30%
Month Family athering (June)	126	84%
Date of Infection malaria	N=18	
This Year	11	61.11%
>one year	7	3.89%
Age	N= 18	
<5 years	4	22.22%
>5 years	14	77.77%
Medication of cases	N= 10	
Artemether Injection	7	70%
Traditional	3	30%
Confirmation of Infection	N= 18	
No	7	38.89%
Yes	11	61.11%
Infection after getting back	N=18	
No	11	61.11%
Yes	7	38.89%
Residency of infected person	N=18	
No	7	38.89%
Yes	11	61.11%
The reason of un-spraying houses	N= 111	
Bypassed	27	24.32%
Absence	41	36.94%
Refusal	43	38.74%
Refusing spraying some rooms cross-tabulated by allergic chronic case		N=500
Accepted	448	89.60%
Refused	52	10.40%
Refusing spraying some rooms due presence of allergy		N=52
Not refused IRS	29	55.77%
Yes refused IRS	23	44.23%
Refusing spraying some rooms effect of IRS on wall painting	N= 500	
Accepted	448	89.60%
Refused	52	10.40%
effect of IRS on wall painting	N=500	
Yes	22	4.40%
No	478	95.60%

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