



ISSN: 2348-5906

CODEN: IJMRK2

IJMR 2021; 8(2): 70-76

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www.dipterajournal.com

Received: 19-01-2021

Accepted: 23-02-2021

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Infectivity rate of anopheles mosquito species and the community perception after indoor residual spraying programme in Awka and Environs, Anambra state, Nigeria

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Abstract

The infectivity rate of anopheles mosquito species were studied after Indoor Residual Spraying (IRS) in three communities in the study area between April and December 2013. Indoor biting adult mosquitoes were collected using Pyrethrum Knockdown Collection (PKC). The physiological states of female anopheles mosquitoes collected indoors was determined using abdominal grading. The female anopheles mosquitoes were dissected for infection with sporozoites. Questionnaires were administration on 120 study participants to ascertain their perception about IRS. A total of 1,109 Anopheles mosquitoes were collected. Of this number, 1,044(94.14%) were *Anopheles gambiae* while 65(5.86%) were *An. funestus*. A total of 355(32.01%) anopheles mosquitoes were unfed, 513(46.26%) were freshly fed while 241(21.73%) were gravid. A total of 241 female *anopheles* mosquitoes were dissected and none was infective. All the 120(100.0%) respondents had heard about IRS, but a small proportion still had negative perceptions towards IRS. Adequate community sensitization is needed, prior to IRS.

Keywords: *Anopheles gambiae*, *Anopheles funestus*, sporozoites, IRS

1. Introduction

Anopheles mosquito species are the vectors of the malaria parasites. *Anopheles gambiae* and *An. funestus* amongst others, when infected with sporozoites of malaria can transmit it from human to human during their bloodmeal [1-3]. The control of the vectors is an important approach in controlling the malaria disease [4]. Indoor residual spraying is one of the major means of curtailing the activities of the malaria vectors [5].

The community knowledge and perceptions about house spraying have been found to be critical for the IRS programme to be successful [6]. Previous studies demonstrated that community understanding and beliefs about the purpose of an IRS programme varied [7, 8]. Other studies have demonstrated that communities have positive expectations when IRS or related prevention interventions are introduced [9, 10]. However, they may have fears and concerns about IRS programmes, which may lead to refusal of IRS in their houses and community [9, 10]. Therefore, addressing community concerns about IRS and ensuring that misperceptions are corrected ensures positive responsiveness during such intervention programmes [7].

Understanding of the function of the IRS programme has been related to community compliance with the programme [11]. Spraying coverage also depends on whether members of households perceive the IRS programme intervention as beneficial, in terms of how effective the insecticide is against mosquitoes and other nuisance insects, as well as the unwanted side effects [12]. It is therefore necessary to understand community beliefs and knowledge when planning or evaluating vector control activities [7]. This study was to evaluate the effectiveness of IRS program in controlling malaria vectors in the communities and also to investigate the people's perception to IRS programme. The specific objectives also include the determination of the infectivity rate of malaria vectors in the sprayed communities after IRS.

2. Materials and Methods

2.1 Study area

The study was conducted in Amansea and Ebenebe communities in Awka North and Awka metropolis in Awka South Local Government Area, Anambra State. The communities lie between the geographical coordinates of 6^o, 9' and 6^o, 24' North latitude and 6^o, 58' and 7^o, 10' East longitude. They are located in the tropical rainforest zone. The communities experience two seasons in a calendar year (dry and wet seasons). The area has a relative humidity of 70% in dry season, and may reach 80% during rainy season. The study area experience and annual rainfall of about 2000-3000mm [13]. The daily temperature ranges from 26-35 °C during the dry season, from November to March, and from 22-30°C during wet season, from April to November. The three communities shares boundaries. Awka is urban, Amansea is sub-urban while Ebenebe is a rural community. The 3 communities are within the Anambra State capital territory. The population of Awka North is 112,192 while Awka South is of 189,654 [14]. The inhabitants of the area are mainly Igbos and are predominantly Christians with a few traditional religionists. The literacy level is high as most of the inhabitants had at least a first school-leaving certificate. The communities has streams and other water bodies for domestic activities which its banks may serve as breeding sites for mosquitoes.

2.2 Community mobilization

Informed consent of the heads of households whose compounds were used for the study was obtained through advocacy visits and proper explanation of the purpose of the study. The general community was mobilized through announcements in public places. All volunteer mosquito collectors were properly informed of the nature of the study.

2.3 Study design and sampling techniques

The study was a cross sectional survey of the community to determine the population and infectivity rate of anopheles mosquitoes. The indoor biting adult mosquitoes were collected using pyrethrum-based insecticide knockdown collection (PKC) method [15]. Random sampling technique was used to select the 24 households (Eight households in each community) for the study. Information on the people's perception of indoor residual spraying programme for eradication of malaria was obtained using structured questionnaire.

2.3.1 Collection of indoor biting and resting adult mosquitoes using pyrethrum knockdown collection method

Indoor biting and resting adult mosquitoes were collected from the three towns under study, using PKC between the hours of 6.00am and 9.00am in the morning [16]. Large white sheets were laid wall to wall on floors of the rooms and all doors and windows were shut. A pyrethroid-based insecticide aerosol (Baygon) was sprayed inside the rooms only, for houses with ceilings, but both inside and outside on the house eaves and every possible escape route of the mosquitoes for houses without ceilings. After 20 minutes, the spread sheets were systematically folded and taken outside where the mosquitoes were collected using forceps, into a wet Petri dish overlaid with filter paper placed over dampened cotton wool.

2.4 Identification of collected mosquitoes

The identification of collected mosquitoes was done at the National Arbovirus and Vector Research Centre Laboratory, Enugu. The mosquitoes were identified using the gross morphology of the species, including the external morphology of the palps, antenna, proboscis, patches of pale and black scales on the wings and legs and the terminal abdominal segments [15, 17].

2.5 Physiological state of adult female mosquitoes collected indoors

The physiological states of female anopheles mosquitoes collected indoors was determined using the method described by Service [18], who grouped them into four stages. Unfed mosquitoes were mosquitoes that had flat abdomen indicating that they have not had any bloodmeal. Freshly fed mosquitoes were those that were just fed and their abdomens appeared reddish in colour. Gravid mosquitoes were mosquitoes that have fed, rested and completely digested their bloodmeal. Their abdomen becomes fully dilated and whitish.

2.6 Dissection of mosquitoes for infection with sporozoites of malaria parasites

Only fed female anopheles mosquitoes collected during PKC in the three communities were dissected at the Laboratory of the National Arbovirus and Vector Research Centre, Enugu, using the pressing method [16, 19, 20]. This involved the use of finely pointed forceps for picking mosquitoes and dissecting needles for dissecting the mosquitoes. With the legs and wings of mosquito detached from the body, the body was placed on a clean microscope slide. Small drop of normal saline was placed on the slide around the head, the slide was mounted on the dissecting microscope and dissected under x10 objective lens. It is essential that illumination of transmitted light is adjusted so that the glands show up clearly against the background. An entomological needle was held in the left hand and placed flat across the thorax. Very gentle pressure was exerted which caused the two trilobed salivary glands to pop out from the end of the neck, accompanied by fat globules, some muscle fibre and other tissues. The pressing was gently done to avoid squeezing out much tissue which will make gland location to be difficult. When the glands were located, they were freed from the debris and pulled to the edge of the drop of saline, covered with a cover glass, were ruptured by pressing the cover slip with a dissecting needle and examined under the microscope using x40 objective and if the mosquito is infective, the small slightly sickled-shaped motile sporozoites will be seen.

2.7 Questionnaire administration on people's perception and attitude about indoor residual spraying

A total of 120 structured questionnaire, 40 in each of the communities were administered to the head of households or their proxies in the three communities to collect data on the socio-demographic characteristics such as sex, age, educational level attained, occupation, marital status, place of residence (rural/urban). Other data collected included: knowledge of the type of insecticides that could be used for IRS, the parts of the house that were sprayed with these insecticides, importance of IRS, role of household heads in ensuring the success of an IRS programme, knowledge on frequency of spraying and the time of spraying. A checklist was developed consisting of a set of questions. The questions

and the correctness of answers were derived from Ministry Of Health and World Health Organization indoor residual spraying guidelines [6, 21]. Respondents were considered knowledgeable if they had responded correctly [21, 22] to at least three questions. They were categorized as not knowledgeable about IRS if they responded correctly to less than three questions. Data on the source of IRS information as well as the preferred source of health education were also collected. Regarding perceptions, respondents were asked if they thought the IRS programme was beneficial or not. They were further asked about the perceived benefit as well as negative effects of the IRS programme. Regardless of whether respondents mentioned perceived benefits or not, they were still asked about the perceived negative effects of the IRS programme. Data on respondents' perceptions about spraying teams entering houses, as well as the requirement to move out

property prior to spraying, was also collected.

2.8 Data analysis

Descriptive statistics such as frequencies and percentages were used to analyze all the data obtained from the study.

3. Results

A total of 1,109 anopheles mosquitoes were collected from the three communities. Of this number, 1,044(94.14%) were *An. gambiae* while 65(5.86%) were *An. funestus*. Of the total collection, 355(32.01%) were unfed, 513(46.26%) were freshly fed while 241(21.73%) were gravid. Of the 513 freshly fed mosquitoes, 496(96.69%) were *An. gambiae* while 24(3.31%) were *An. funestus* (Table 1).

Table 1: Distribution and physiological states of anopheles mosquitoes collected from the three Communities

Species	Abdominal status	Amansea (n=361)	Ebenebe (n=367)	Awka (n=381)	Total
<i>Anopheles gambiae</i>	Unfed	127 (38.37%)	106 (32.02%)	98 (29.61)	331 (93.24%)
	Freshly Fed	137 (27.62%)	187 (37.70%)	172 (34.68%)	496 (96.69%)
	Gravid	80 (36.87%)	63 (29.03%)	74 (34.10%)	217 (90.04%)
	Sub-Total	344 (90.29%)	356 (97.00%)	344 (90.29%)	1044 (94.14%)
<i>Anopheles funestus</i>	Unfed	8 (33.33%)	5 (20.83%)	11 (45.83%)	24 (3.31)
	Freshly Fed	6 (35.29%)	2(11.75%)	9 (52.94%)	17 (3.31%)
	Gravid	3 (12.50%)	4 (16.67%)	17 (70.83%)	24 (9.95%)
	Sub-Total	17 (4.46%)	11 (3.00%)	37 (9.71%)	65 (5.86%)
	Grand total	361 (32.55%)	367 (33.09%)	381 (34.36%)	1109 (100%)

A total of 241 female *An. gambiae* and *An. funestus* mosquitoes were dissected to determine their infectivity rate

in the three communities. Of the 241 female *Anopheles* mosquitoes dissected, none 0(0%) was infective (Table 2).

Table 2: Infectivity of female anopheles mosquitoes in Ebenebe, Amansea and Awka

Communities	Species	No Examined	Number Infective	% of Infectivity
Amansea (n=83)	<i>Anopheles gambiae</i>	80	0	0
	<i>Anopheles funestus</i>	3	0	0
Ebenebe (n=67)	<i>Anopheles gambiae</i>	63	0	0
	<i>Anopheles funestus</i>	4	0	0
Awka (n=91)	<i>Anopheles gambiae</i>	74	0	0
	<i>Anopheles funestus</i>	17	0	0
	Total	241	0	0

A total of 120 persons participated in the knowledge and perception studies of IRS (Table 3). The study participants consisted of 91(75.8%) males and 29(24.2%) females. Their age ranged from 20 to 70 years. The majority 92(76.7%) of

the respondents were married. Others were students 19(15.8%), and traders 46(38.8%). The majority of the participants had acquired secondary education 52(43.3%), only a few had no formal education 3(2.5%).

Table 3: Socio- demographic characteristic of respondents

Variable	Frequency (n=120)	Percentage (%)
Sex		
Male	91	75.8
Female	29	24.2
Age		
20-29	23	19.2
30-39	30	25.0
40-49	18	15.0
50-59	23	19.2
60-69	15	12.5
Above 70	11	9.1
Marital Status		
Single	18	15
Married	92	76.7

Widow	8	6.7
Divorce	0	0.0
No response	2	1.7
Occupation		
Student	19	15.8
Farmer	32	26.7
Trader	46	38.3
Technician	6	5
Civil Servant	12	10
Fishermen	3	2.5
Educational Status		
Non formal education	3	2.5
Primary education	21	17.5
Secondary education	52	43.3
Tertiary education	41	34.2
No response	3	2.5

All the respondents 120(100.0%) had heard about IRS. A total of 57(47.5%) of the respondents mentioned Lambda-cyhalothrin (ICON) as the insecticide used for IRS, 31(25.8%) mentioned DDT, 6(5.0%) mentioned Deltametrin, 20(16.7%) said they did not know while 6(5.0%) did not respond to the question. Regarding the exact part of the house to be sprayed with insecticides, 88(73.3%) mentioned the

different surfaces of inner walls and 3(2.5%) said they did not know. Regarding the importance of IRS, 108(90.0%) said that IRS is important because it will help to kill mosquitoes. Respondents who had ever heard about IRS were asked about the frequency of IRS, 144(95.0%) of respondents reported that IRS should be conducted after every six months. Only a few said they did not know the frequency of IRS (Table 4).

Table 4: Respondents' knowledge of indoor residual spraying

Variable	Frequency (n-120)	Percentage (%)
Ever heard of IRS		
Yes	120	100.0
No	0	0.0
Insecticide employed for IRS		
DDT	31	25.8
Lambda-cyhalothrin	57	47.5
Deltametrin	6	5.0
Don't know	20	16.7
Non- response	6	5.0
The exact parts of the house to be sprayed during IRS		
On the surface of inner walls	88	73.3
On the surface of outer walls	5	4.2
On the inner surfaces of the roof	24	20.0
Don't know	3	2.5
Importance of IRS (multiple responses accepted)		
To kill mosquitoes	108	90.0
To kill domestic insect	48	40.0
To kill rodents	16	13.3
Don't know the importance of IRS	8	6.7
Controlling malaria	17	14.2
Roles of household heads in IRS (multiple responses accepted)		
Removing some of the household items from the house prior to spraying	83	69.2
Removing people from the house prior to spraying	28	23.3
To ensure that people stay out of the house during and after spraying (for at least 2 hours)	42	35.0
Provide spraying team with clean water for mixing chemicals	17	14.2
Don't know	3	2.5
Frequency of spraying (multiple responses accepted)		
Once	3	2.5
After every three months	24	20.0
After every six months	114	95.0
Annually	53	44.2
Don't know	14	11.7
Time of spraying		
In the morning hours	115	95.8
During the day	2	1.7
At night	0	0.0
Don't know the time of spraying	3	2.5

A total of 120 respondents who had heard about IRS, 84(70.0%) reported that IRS will reduce malaria episodes, 36(30.0%) said it will reduce mosquitoes, while a small proportion 8(6.7%) said IRS will reduce rodents (Table 5). Respondents' perceptions about IRS varied from perceived benefits to perceived negative effects. The commonest perceived negative effects of IRS were: skin allergies

17(46.7%), sneezing and running nose 40(33.3) while 3(2.5%) said it can lead to negative health effects such as cancer. Regarding peoples' feelings about IRS, most respondents 57(47.5%) were happy and like IRS to be repeated while 45(37.5%) said the chemicals used for IRS discolour walls, 29(24.2%) do not like the odour, while 21(17.5%) did not like IRS.

Table 5: Respondents' perceptions of Indoor Residual Spraying

Variable	Frequency (n-120)	Percentage (%)
Benefits of IRS (multiple responses accepted)		
To reduce mosquitoes	36	30.0
To reduce malaria episodes	84	70.0
To reduce medical expenses due to malaria	23	19.2
To reduce other insects	19	15.8
To reduce rodents	8	6.7
Negative effects of IRS (multiple responses accepted)		
Respiratory tract infections	17	14.2
Nervousness	26	21.7
Anxiety	13	10.8
Skin allergies	56	46.7
Pollute the environment	17	14.2
Contaminate food in the houses	28	23.3
Sneezing and Running nose	40	33.3
Convulsions in children	6	5.0
Very irritating to the eyes and nose	21	17.5
Can lead to cancer	3	2.5
Peoples' feelings about IRS (multiple responses accepted)		
Do not like the odour	29	24.2
Happy and would like it be repeated	57	47.5
It increases malaria in my community	0	0.0
It is government intrigue to write off some money	3	2.5
Would not like it to be repeated	11	9.2
Pollutes the food and environment	16	13.3
Take it away it does not employ our children	2	1.7
It is a disturbance to the community	0	0.0
Do not like it, do not spray	21	17.5
Discolouring of walls	45	37.5
No- response	0	0.0

Majority of respondents indicated that their households were sprayed 94(78.3%) while only 26(21.7%) of the respondents indicated that their households were not sprayed (Table 6). The most reason for not spraying the houses were: spraymen were not given permission to spray 9(7.5%) because of interference with privacy and security of household property. No one at home 5(4.2%), inconvenience that they would not be able to move some of their property out of the house as required prior to spraying 4(3.3%). The households

65(54.2%) indicated that the sprayman explained the reasons for spraying while 26(21.7%) said that the sprayman did not explain the reasons for spraying. Majority of respondents 51(42.5%) were not happy with the spraying service. Among those that were not happy majority 17(14.2%) said it is because of damage to their belongings, 13(10.8%) was the spraymen's conduct while 3(2.5%) was discolouring house walls.

Table 6: Respondents' perceptions about spraying teams entering houses as well as requirement to move some property out prior to spraying

Variable	Frequency (n-120)	Percentage (%)
Was your house sprayed (2013)		
Yes	94	78.3
No	26	21.7
Why?		
Inconvenience	4	3.3
No one came to spray	3	2.5
Sprayman not given permission to spray	9	7.5
No one at home	5	4.2
Don't know	3	2.5
Was the house / room you sleep in sprayed		
Yes	91	75.8
No	23	19.2
Did sprayman explain the reason for spraying		

Yes	65	54.2
No	26	21.7
Are you happy with the spraying service		
Yes	51	42.5
No	43	35.8
Reasons?		
Smell unsightly	4	3.3
Inconvenience	5	4.2
Damage to belongings	17	14.2
Spraymen's conduct	13	10.8
Discolouring house walls	3	2.5
Where your inner house walls re-plastered or painted after spraying		
Yes	3	2.5
No	91	75.8

4. Discussion

The observed physiological state of the indoor biting anopheles mosquitoes revealed 46.26% were freshly fed. The observation in this study is lower than Ezihe^[23] who reported that 74.4% of *An. gambiae* mosquitoes collected indoors in their study in Enugu State were bloodfed. The lower number of freshly fed anopheles mosquitoes collected indoors in this study might be due to changes in their feeding behavior after IRS, but having bloodmeal in the first place is an indication that they had contact with humans and there could be chances of malaria transmission when they are infected with sporozoites^[2]. But, after dissection, none of the anopheles mosquitoes were found carrying sporozoites. The zero infectivity observed, may also suggest a reduced chances of the malaria disease transmission in the area.

All of the study respondents, 100% have heard of IRS. Also, almost all respondents who have heard about IRS knew its importance in reducing mosquitoes and malaria, although prior to this study, mass community mobilization and Sensitization campaigns for IRS were conducted. This may explain the significant level of knowledge. A large proportion of the study respondents having a positive perception towards IRS was consistent with findings in other studies^[8, 11] who reported positive community perceptions when IRS or related prevention interventions were introduced. Majority of the respondents here, 70% indicated that IRS programme reduces malaria episodes. This is in contrast with a study^[24] which reported on Knowledge and beliefs about malaria transmission and practices for vector control in Southern Mexico and noted that people are more concerned about the mosquitos' nuisances than the malaria. In this study, only a few had a negative perception that IRS causes skin allergies, sneezing and running nose and discolouring the walls.

Additionally, this study also observed that despite many having positive perceptions towards IRS, others still had negative perceptions towards its use. These negative perceptions may be attributed to spraymen's conducts, misinformation about the insecticide used and misunderstanding the function of IRS^[10, 11]. This, therefore, calls for special IRS promotion efforts and strategies that target such limited knowledge communities^[12, 22].

5. Conclusion

This study has revealed that anopheles mosquitoes may have little or no sporozoites infection a few months after and IRS programme in a community. Also, the study has shown that a good number of people in the area has the right knowledge and perception about IRS. Although the majority of respondents had positive perceptions, a small proportion still

had negative perceptions towards the use of IRS. Therefore, it is recommended that adequate community mobilization and sensitization is needed, prior to introduction of IRS to address the identified knowledge gaps.

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