Shendi University Journal of Applied Science, Issue (10) , June 2023 (12): p 141-154

Efficiency and Utilization of Long-Lasting Insecticide Nets (LLINs) in Selected Villages of ALRahad Locality, Gedarif State, Sudan2014

Mohammed Abdulslam A Ishag[1] , Salah Eldin M Elkhalifa,[2] Mohamed E M Saadeldin[3]

[1]Director of Health Affair in Rahad Locality, Gedarif State

[2]General Director of Environmental Health and Food Control - Federal Ministry of Health –Sudan

[3] Faculty of Medicine, U of Gezira, P O box 20, Wad Medani, Sudan

Abstract

A cross-sectional study was conducted in6 selected villages of ALRahad locality in Gedarif state, eastern Sudan. The study aimed to evaluate the efficiency and utilization of (LLINs) which it was distributed in 2012**.** Six villages of the ALRahad locality were selected for the study. For bio-efficacy, each village was selected as a systematic random sample, after any five houses two LLINs were randomly taken, and 60 LLINs were collected with clear labels for each LLIN (PermaNet2.0®). The mosquito chosen for the bioassay test was a susceptible Dongola colony of Anopheles *arabiensis*, LLINs were transported to the National public health laboratory (NPHL) in Khartoum. A total 373 of households were randomly selected as study representative samples. Questionnaires adopted by WHO were used as study tools**.** The results showed that 61% of the households used nets immediately after sunset**.** Only 40% of the families with nets were infected with malaria in the last 2 yr. The bioassay study revealed that 66.7% of the test colony was knocked down after 1hr and 52% died after 24 hr. The highest mortality (90%) was found in Jarmi village, while the minimum was in Rumbik village (25.5%). The study concluded that the efficacy of LLINs was moderate due to poor practice, and inappropriate utilization (61%). Distributing LLINs together with intensive awareness-raising about use and storage is recommended.

Keywords: Anopheles arabiensis, Bioassay, bio-efficacy, LLITNs, and Utilization.

1. Introduction

Malaria is an entirely preventable and treatable mosquito-borne illness. In (2013), 97 countries had ongoing malaria transmission. An estimated 3.4 billion people are at risk of malaria, of from which 1.2 billion are at high risk. In high-risk areas, more than one malaria case occurs per 1000 population. There were an estimated 207 million cases of malaria in (2012) and an estimated 627, 000 deaths. Around 90% of all malaria deaths occur in sub-Saharan Africa (SSA). In (2012), malaria killed an estimated 482, 000 children under five years of age. That is

1300 children every day or one child almost every minute. Between (2000) and (2012), the scale-up of interventions helped to reduce malaria incidence rates by 25% globally, and by 31% in the WHO African Region. The global malaria mortality rate was reduced by 42% during the same period, while the decrease in the WHO African Region was 49% [1]. This scale-up of malaria interventions saved an estimated 3.3 million lives. Approximately 90%, or 3 million, of these are in the under-five age group in SSAA [1]

Malaria is transmitted through a single bite from infected female *Anopheles* mosquitoes (Diptera: Culicidae). There are five types of human malaria parasites, namely *Plasmodium vivax*, *P. malariae* (World-wide), *P. ovale*, and *P. falciparum*, which is the most common tropical and subtropical is the prevalent species, at the same time, the most deadly type of malaria infections[2]. Last species discovered is *P. knowlesi* is a primate malaria parasite commonly found in Southeast Asia and transmitted by the bite of an Anopheles mosquito. It causes malaria in long-tailed macaques (*Macacafascicularis*), but it may also infect humans, either naturally or artificially[3]. An insecticide-treated net(ITNs) is a mosquito net that repels, disables and/or kills mosquitoes coming into contact with insecticide on the netting material. There are two categories of ITNs: conventionally treated nets and long-lasting insecticidal nets: Conventionally treated net is a mosquito net that has been treated by dipping in a WHO-recommended insecticide. To ensure its continued insecticidal effect, the net should be re-treated after three washes, or at least once a year. A long-lasting insecticidal net is a factory-treated mosquito net made with netting material that has insecticide incorporated within or bound around the fibres. The net must retain its effective biological activity without re-treatment for at least 20 WHO standard washes under laboratory conditions and three years of recommended use under field conditions[4].The durability of Long-Lasting Insecticidal Nets (LLINs) in the field has become a critical issue for the success of malaria control in areas where LLINs are being applied for malaria prevention for two main reasons: first, it has been shown by various modeling exercises that increasing LLIN durability by one or two years on average would have a huge impact on the cost of malaria prevention, inthe order of 500-700 million US dollars over 5 years; and second, there are increasing data suggesting that there is a wide variation of LLIN performance between different locations or populations This implies a need to acquire country or region specific data on LLIN performance to feed into management decisions[5].The scaling up of LLINs is one of the important strategies of the National Vector

Control Programme (NVCP) towards control of malaria. The LLIN is a factory pre-treated mosquito net which retains its insecticidal activity even after 20 standards WHO washes and has a minimum life of 3 years when used under field conditions. The LLINs are generally more effective than conventional Insecticide Treated Nets (ITN), because they have an even and quality-controlled application of insecticides. They are also more cost-effective in the long term, as they do not require re-treatments like the conventional ITNs [6].ITNs were developed in the 1980s, and LLINs were developed and introduced to the market about a decade later in the late-1990s. LLINs have a clear advantage over ITNs due to a much longer residual efficacy, thus eliminating the need to re-treat every six months. While LLINs have replaced ITNs in most countries, ITNs are still available in certain retail markets, particularly in Asia. Donors almost exclusively fund LLINs over ITNs[7].The objective of the Sudanese National Malaria Control Strategy (NMCS) 2011-2015 was to reduce the morbidity and mortality of malaria by 50% by 2015 all over Sudan (compared to reported cases in 2009). In 2011, in comparison with 2009، the incidence of reported confirmed cases decreased by 36%, and the reported number of deaths by 46%. Reported total malaria incidence has decreased by in 2011in comparison to 2000[8]. Malaria endemicity is influenced by various factors, which include agricultural activities, migration movements, wars, limited resources, drug resistance, mosquito density, larval breeding sites, temperature, insecticide resistance, environment and socio-economic [9].

In Gedarif State, eastern Sudan, malaria cases arise after the rainfall season. The prevalence of malaria in Gedarif state is 49,812 in (2012), 25,143 cases in (2013) and 50,978 cases in (2014). During the Malaria Indicator Survey (2012), Gedarif state was considered a high incidence among the states (10.9%), carried predominantly by *A.arabiensis* mosquitoes[10]. The malaria control program (MCP) in Gedarif State, Ministry Of Health, is working hard to control this problem. They have started distributing long-lasting insecticide-treated nets (LLINs) for all groups, since (2011). In (2014), all groups of inhabitants for the entire state were covered with LLINs [11]. The main vector control methods include the use of insecticide-treated nets(ITNs) and indoor residual spraying (IRS). Both interventions rely on the continuing susceptibility of *Anopheles* to a limited number of insecticides. However, insecticide resistance, in particular pyrethroid-DDT cross-resistance (CR), is a challenge facing malaria vector control(VC) in Gedarif State, because pyrethroids represent the only class of insecticides approved for treating

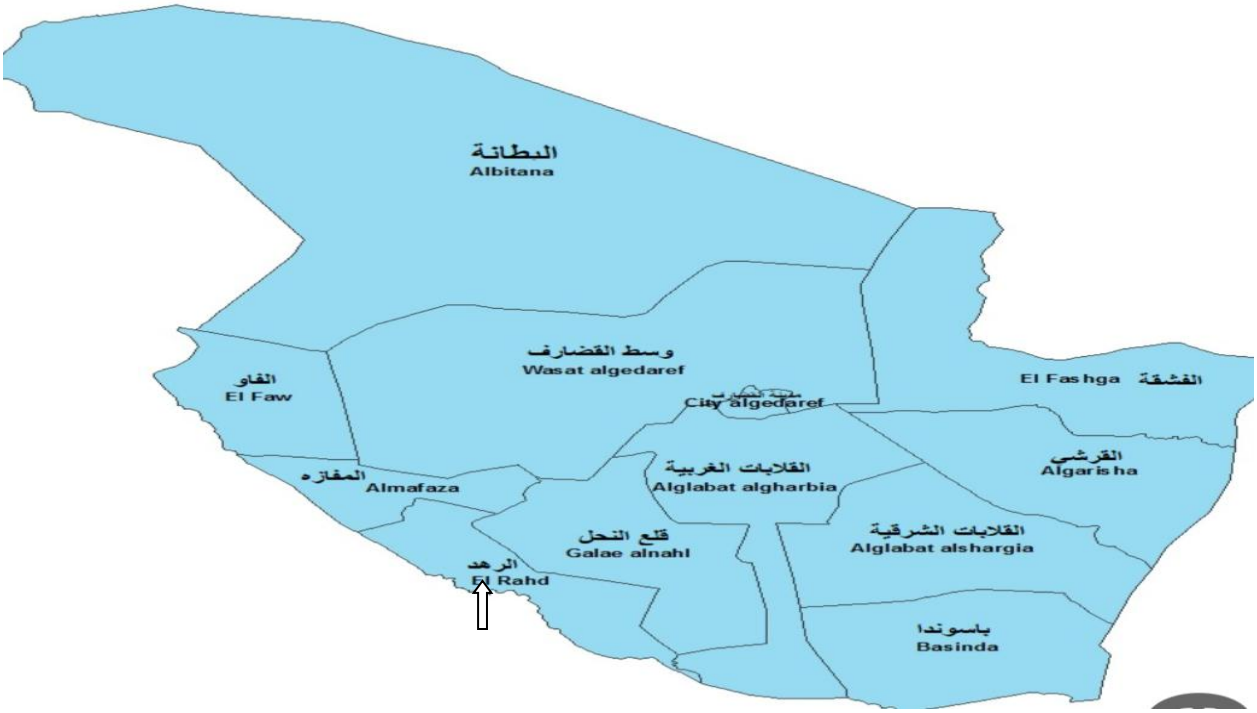
bed nets, and also is commonly used for IRS. Chemical control has always been the main strategy of vectors control in Gedarif State [12].

2. Materials and Methods

ALRahad locality is one of 12 localities of Gedarif State Eastern Sudan.

The locality is bordered by ALFao locality in north, Sennar state in the west, Gala alnahl locality east and galabat algarbia in the south .

ALRahad locality divided in to 3 administrative. The population of the locality is estimated as 224000 consisting of most of the tribes of Sudanese. The majority (65.9%) of the population works in agriculture. The vegetation of the state is poor savannah. The soil is clay and muddy. The Rahad River pass through the locality from the south to north. Average of the rainfall is approximately 612 mm. More than 75% of houses in Gedarif state are huts.(gatia).



Map of Gedarif state, Eastern Sudan

Sampling techniques and Sample size

Stratified sampling technique was adopted for the study First three administrative units of the locality were selected: according to their population size, then two villages from each were randomly selected. The sample size of the households was calculated according to the following formula:

$n=z^2xqxp/ d^2$

Whereas:

n =sample size, z=1.96, p=Prevalence rate, q=1-p, d=error 0.05 or 0.0025

$n=1.96^2X1-50/100 X 50/100/ (0.05)^2$

3.8 X- 0.49X 0.5/0.0025 = 372.4Household, i.e. Household (HHs).

The number of households interviewed in each village was calculated as percentage of nets distributed over the total number of nets distributed in the six selected villages.

Table (2.1) : Distribution of household that selected from studt area .

Village	Administrative unit	Population	No. of HHs	No. of nets distributed	%	No. of HHs interviewed
Hilat Elkhalifa 2	Hawata	2,455	344	1343	18	67
Alslam	Hawata	1,906	329	1053	15	56
Romek	Bazora	536	100	294	4	15
Komur Albasher	Bazora	1,988	327	1104	15	56
Jarmai	Wad Elshaer	5,660	988	3204	42	157
Wad Abuazaz	Wad Elshaer	808	145	441	6	22
Total		13,353	2,233	7,439	100	373

The data was collected using a well-structured questionnaire to study the attitude and practice of community HHs regarding LLINs through a community survey. For the bio-efficacy tests,

each village was selected as a systematic random sample, i.e. after any 5thhouse,2 LLINs were randomly taken.

We were collected60 LLINs for bioassay of susceptible colony of An. arabiensis in national public health laboratory(NPHL) conducted clear label for each net, including type, condition, time of distribution, number of washings, and storage. Bioassay was carried out according to WHO procedure [13]. For the method of the bioassay (Refer to the Reference 13)

Data were collected by a team of four trained interviewers by the authors.

The collected data was entered to excel sheet software and analysed using suitable inferential statistics, in addition to descriptive statistic (mean, median, percentage). Bioassay was subjected Abbott's formula for correcting the mortalities.

Results

The questionnaire results showed that in about 54.6% of the families there is one women in productive age, and >72% of the families have at least one child under 5 yr (range: 0- >3 children under 5 yr) (Fig.1). More than 80% of families found to have LLINs (Fig.2).

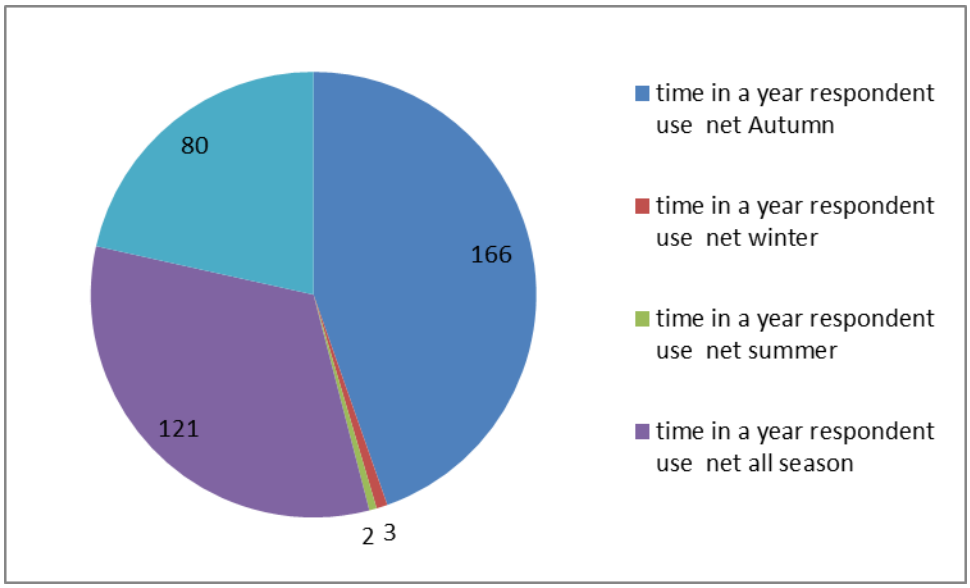


Fig. 1: time in a year households used LLINs, Rahad Locality

(Fig.1). About 61.49% of the owners use the nets immediately after sunset (i.e. between 5:30 and 6:30 pm, winter summer, respectively). Approx. 13.9% use nets after Isha prayer (between 7:30 to 8:00 pm). However, around 3% use nets after midnight.With regard to the time (season) of the

use of the nets, only 32.35% use them in all season , 44.38% use nets during the rainy-season only (Autumn), 0.8% use them during winter, and 0.5% during the summer season

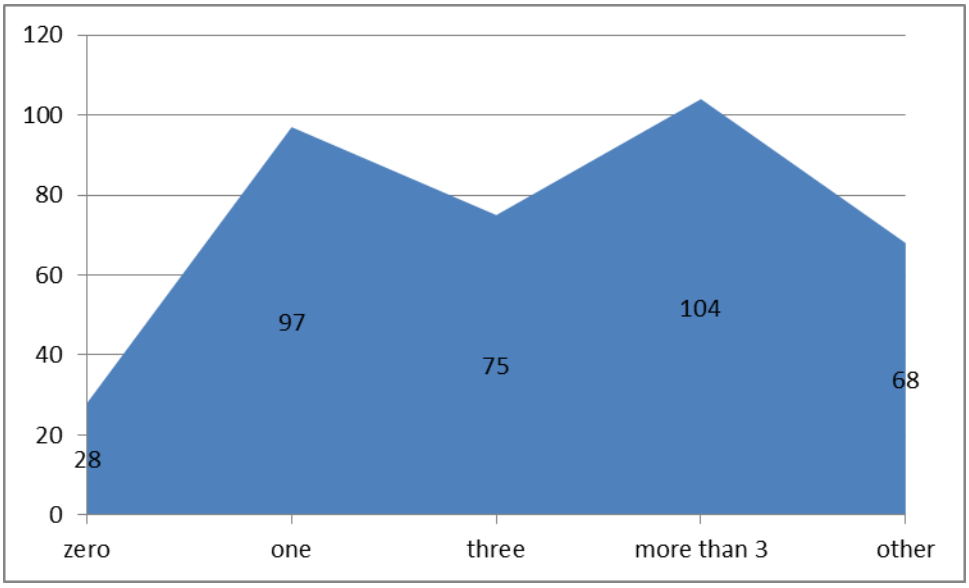


Fig. 2. Frequency of washing LLINs by families /yr in the villages of Rahad locality,Gadarif State, Eastern Sudan .

The response to washing the nets question showed that 7.5% did not wash the nets, 26% washed them once, 20% washed them 3 times, 27.9% more than 3 times, others did not mention the figures (18.27%) ((Fig. 2). After washing the nets, 59.4% of the respondents confessed to dry them in under the sun and 19.6% under shaded areas. The rest of the HHS did not respond to the question.

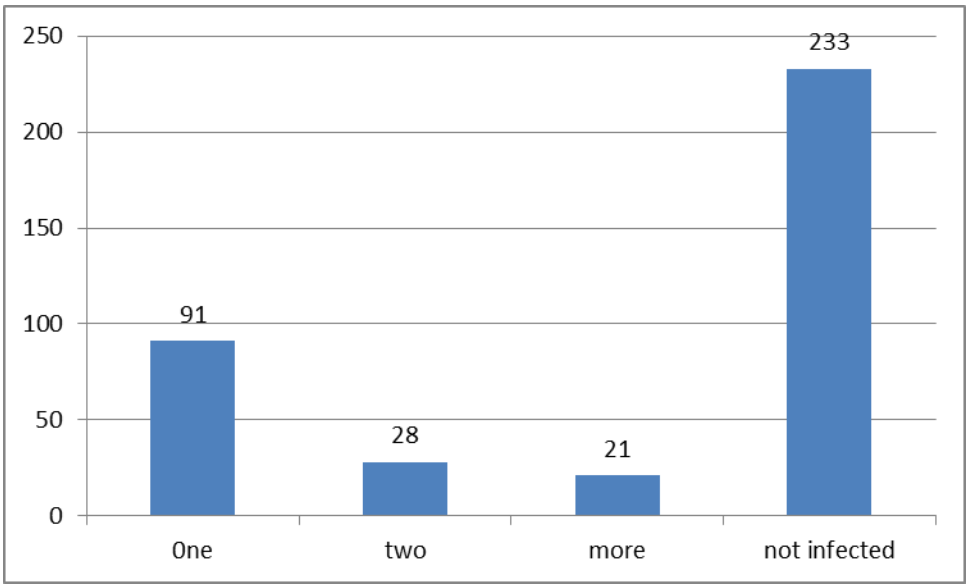


Fig3.: members of families infected by malaria after distributed LLINs2012.

The majority (40%) of families infected with malaria parasite during last 2years after distributed LLINs and 26% of families had one cases only with malaria parasite during a last 2years after distributed LLINs (Fig.3).

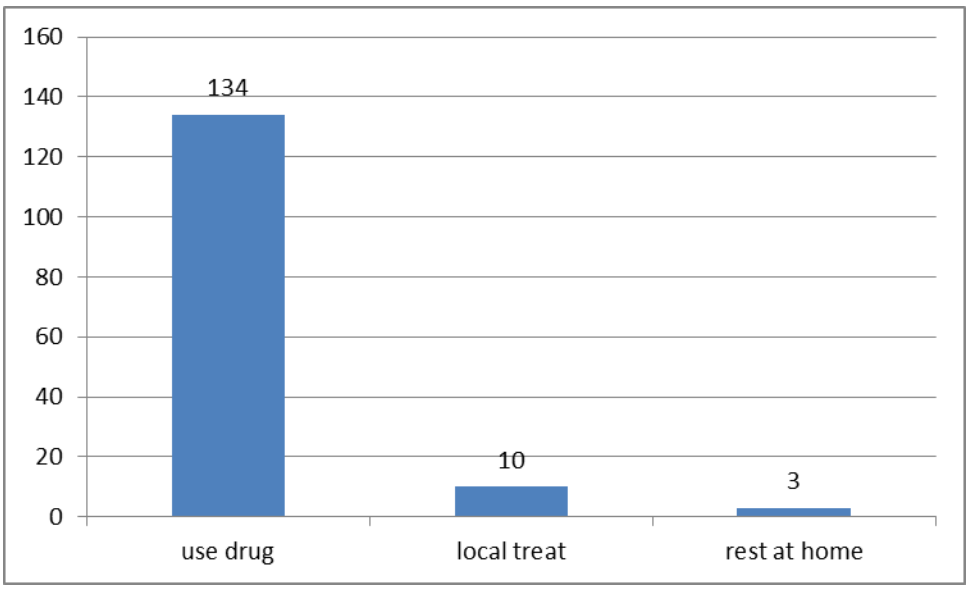


Fig4.: explain treatment seeking behavior of families after infected by malaria disease.

The majority 91% used drug after consultation of medical doctor.

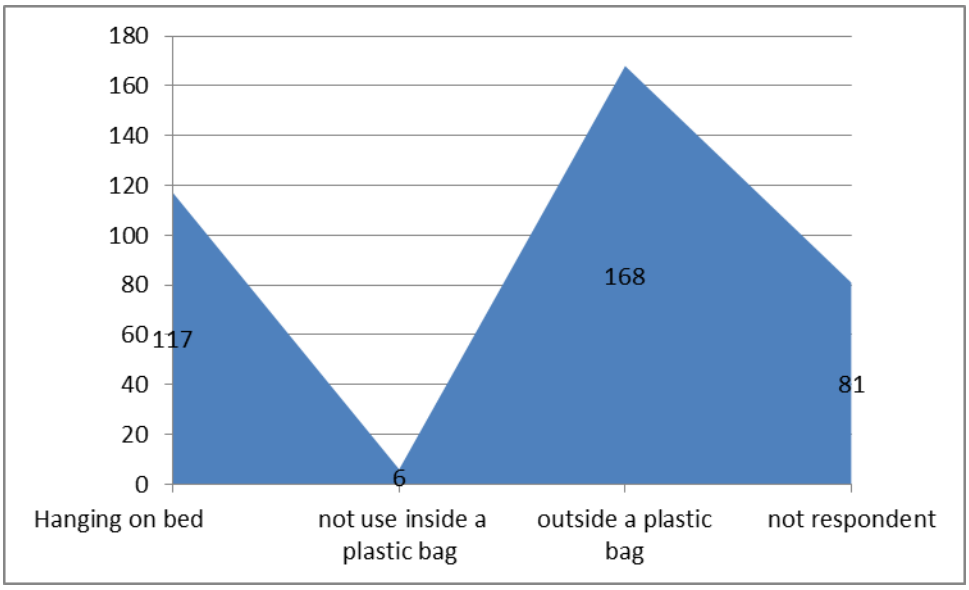


Fig5.: explained situation of LLINs during observation , village, , Rahad locality,2014.

More than 45% of bed net be outside of plastic bag that mean utilized.

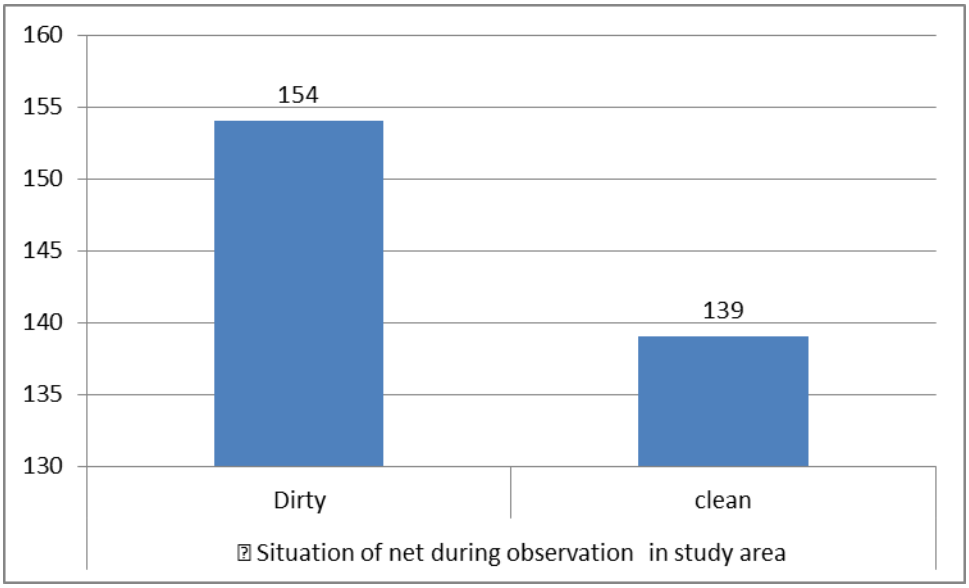


Fig.6 .: explain condition of LLINs during visit, villages, , Rahad locality,2014 .

More than 51% of LLINs dirty.

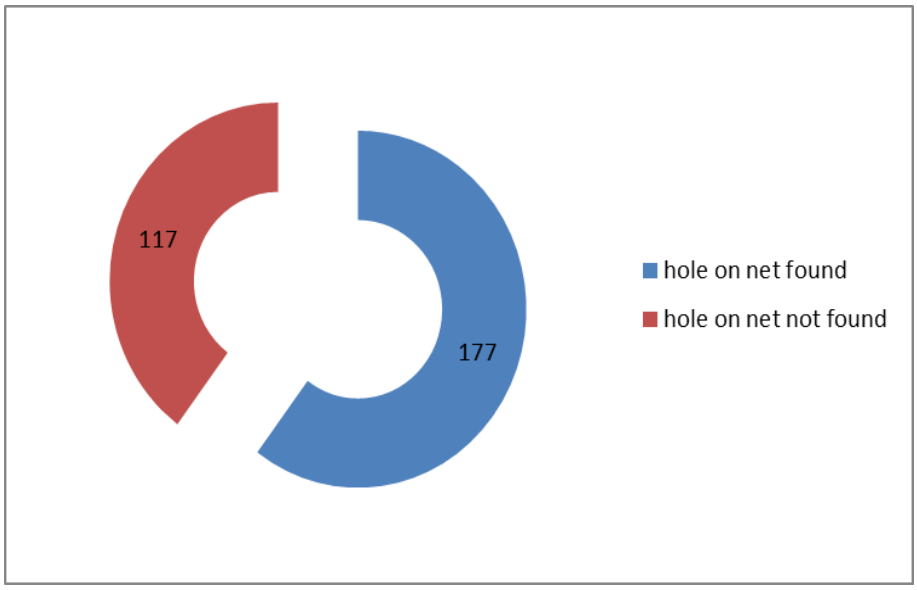


Fig7.: explain a hole or not in it LLINs, villages, ,Rahad locality,2014.

More than 59.5% of LLINs it holed during observation.

Table. 3-1: Bioassay test against susceptible colony of An. *arabiensis* exposed to LLINs utilized in study area is showed 52.5% mortality.

NO	Village	No. of mosquito exposed	Kdafter1hr	No. dead after 24hr	No. alive after24hr	Kd%	Mortality (%)
1	**Jarmi**	250	160	188	62	75	90.0
2	**Wad Aboazaz**	250	102	101	149	49	38.0
3	**Rumbik**	250	80	53	197	39.5	25.5
4	**KumrAlbasher**	250	141	126	124	70	52.5
5	**HilatAlkhalifa**	250	161	94	156	78	47.0
6	**Alslam**	250	184	132	118	92	62.5
Total		1500	828	694	806	66.7	52.5

Table 3-2: A Result showed control mortality is (5.6%), Highest control mortality observed in day one (10%), in LLINs evaluated

Day	Date	No. exposed	Kdafter 1hr	No. after24 hr	No. alive after24 hr	Kd%	Control mortality %
1	**3.11. 2014**	100	12	14	69	2.4	10
2	**4.11. 2014**	100	2	8	90	2.4	5
3	**11.11 .2014**	100	0	2	98	1.6	2
Total		300	14	24	257	2	5.62

Table 3-3: temperature and humidity during test days from NPHL room test.

Day	Temperature ºC	Humidity%
1	28.25	76.25
2	28.25	70.75
3	27.75	69.00
Total	28.00	72.00

5. Discussion

Similar study conducted in eastern Sudan Among the households, 42% and 46.2% respectively had one and two PermaNet® 2.0 inside their houses [14]. clarified that more than 80% of the households was had LLINs, Since distribution a total of 60.5% the nets had been damaged by having holes [15] This study Evident that,47% of the households was had LLINs damaged with holes. A total of 64.7% of the households have reported that they sleep under nets every night [16] that similar this study where approximately 61% of the households used bed nets after sunset directly.

The majority of households used bed net in autumn season, this correspond stratum of eastern Sudan (Gedarif) season malaria in autumn [16]. also LLINs during rainy season, most of its

hanged during sunset. This result not matched to This was later confirmed by observations of the nets that were hanged inside houses and 50.4% of the households were observed with hanged nets inside houses [17],that approve this study; The majority of bed net be inside of room .All samples of bed net was Permanet 2.0,that confirmed LLINs distributed in2012 (NMCPs).In 25 (21.4%) households bed nets received were totally damaged, that approved to a result More than 59.5% of bed net holed during observation. More than 51% of LLINs dirty, main that dust maybe effect in efficiency of LLINs against mosquito and other insect. Approximately 91% of the households consultation to doctors after infected with malaria, that mean good awareness regarding health care. Sixty-three (44.7%) households reported that at least one member of the household has suffered an attack of malaria (both clinical and/or lab-confirmed) during the past three months. (14). in this study approved; approximately 40% of the households received LLINs infected with malaria. Approximately 74% of the household's exposure your bed nets to sunlight directly for drying after washing, that agree It was suspected that exposure from sunlight could degrade the insecticide in the fibres of the bed nets [18].

A total mortality rate of susceptible colony of An. *Arabiensis* exposed to LLINs from study area is 52.5%and control mortality is (5.6%). The Highest control mortality observe in day one (10%), that contradicted this study LLINs are still effective after three years of distribution in the study area (70%) [19].

Conclusion;

The study was concluded that:

- Approximately 61% of house hold used LLINs and efficacy of LLINs was 52.5%.

-Repeated washing of LLINs had increase the efficacy.

-Poor practicing towards LLINs by households.

-Good practicing towards consultation of medical doctor after appear of malaria symptoms**.**

Recommendations; The state and the national control program should monitor the efficacy of LLINs regularly. Intensive Health education to change the practice of washing LLINs at least three time in year, saving it in shade to dry and utilize in all season for protect against mosquito or other insects.

Ethical Consideration: Institutional clearance was obtained from the Blue Nile National Institute for Communicable Diseases (BNNICD) committee and the Ministry of Health in Gedarif State before the project was able to get started. The study utilized the informed

agreement of responders and community leaders obtained the respondents had the option of participating in the study or rejecting it.

References:

1. World Malaria Report (WMR) (2013). Fact Sheet. Global Malaria Programme, World Health Organization.

2. Gilles, H.M. and Warrell, D.A. (1993) Bruce-Chwatt's Essential Malariology, 3rd edition, Edward Arnold, London.

3. Jaap J. van Hellemond and others(2009),Human Plasmodium knowlesi Infection Detected by Rapid Diagnostic Tests for Malaria, Emerging Infectious Diseases, Centeral disease control(CDC),pages1478-1480.

4.WHO (2012). WHO Global Malaria Programme: Position Statement on ITNs.

5.WHO,(2013).Malaria control in humanitarian emergencies: an inter-agency field .

6.National Rural Health Mission (2009). Action Plan for Scaling-up Long Lasting 7.Insecticidal Nets for malaria control in India. Directorate General of Health Services.

WHO, UNITAID(2014) Malaria Vector Control Commodities Landscape 2nd Edition. handbook – 2nd ed.

8. NMCP (2012) .Five years Strategic Plan for the National Malaria Control Programme Sudan (2011 – 2015). Khartoum

9. National Malaria Control Prgramme, Sudan (2010). National Strategic Plan for RBM (2007-2012): 12-13.

10.Federal Ministry of Health ,Sudan ,National Malaria CONTROL Program ,Malaria indicator survey report , (2012).

11. Gedarif state malaria control programme,(2015).

12.WHO (2012). WHO Global Malaria Programme: Position Statement on ITNs.

13. WHO, (2013), guideline for laboratory and field testing on long lasting insecticidal nets

14. Hassan. S. H, Malik. E. M, Okoued. S. I. and Eltayeb. E. M . (2008)Retention and efficacy of long-lasting insecticide-treated nets distributed in eastern Sudan: a two-step community-based study.Malaria Journal2008, 7:85.

15. M Fettene, Meshesha B and Ciara G.(2009).Utilization, retention and bio-efficacy studies of PermaNet® in selected villages in Buie and Fentalie districts of Ethiopia. Malaria Journal 2009, 8:114..

16 .John, B B (2010). A research Dissertation submitted to the postgraduate school in partial fulfilment of the requirement for the award of the degree of Masters of Arts Sociology of Makerere ,University, Kampala.

17. M.H. Kayedia,b,, J.D. Lines, A.A. Haghdoosta,c, M.H. Vatandoostd,Y. Rassid, K. Khamisabadye,(2008) , Evaluation of the effects of repeated hand washing,sunlight, smoke and dirt on the persistenceofdeltamethrin on insecticide-treated nets Tropical Medicine & Hygiene

18. GobirZainab, Tukur Zainab,(2013,0 Post-intervention assessment of long-lasting insecticide nets (LLINs) distributed in the Kano metropolis, Kano State, Nigeria , zamah09@gmail.com).

19 . M Jones, Antoine Sanou, Wamdaogo M Guelbeogo‹ N'Fale Sagnon

‹Paul CD Johnson and Hilary Ranson (2012) Aging partially restores the efficacy of malaria vector control in insecticide-resistant populations of Anopheles gambiae s.l. from Burkina Faso, Joneset al. Malaria Journal2012,11:24