Assessment Of The Effectiveness Of Insecticide Treated Nets (itn) For Malaria Control In Lagos, Nigeria

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Abstract:

A randomised field trial was carried out to find out the effectiveness of lambdocyhalothrin- treated bednet as a malaria control tool in Lagos, Nigeria. A total of one hundred students, between the ages of 18-25 years,, were assigned into three experimental groups (insecticide treated bednets [ITN], untreated bednets [UTN], and controls), for the study. Questionnaires were administered at the onset of the survey to assess the students' knowledge of malaria. Collection and examination of blood samples were carried out using Giemsa staining technique over a period of six weeks to identify *Plasmodium falciparum* levels in the participants. During the period of study, the UTN group (3.75% infected) was generally twice more infected than the ITN group (1.7% infected) and the Control group (11.25% infected) was about 2.5 times more infected than the UTN group. The results showed that the insecticide-treated nets provided a greater level of protection against malaria when compared to the other two groups. As a malaria control tool, ITN is very effective. Further entomological and epidemiological studies need to be carried out to maximize the benefits of this new tool in the fight against malaria.

Introduction

Malaria has been identified as one of the major causes of ill health especially amongst the inhabitants of the tropical and sub-tropical countries. 40% of the world is at risk of malaria but 9 out of 10 cases occur in Africa south of Sahara.[1] Malaria kills a child every 30 seconds, often in combination with other diseases.[1] Malaria is believed to be the largest public health battle being fought south of the Sahara.[2] Its control has been targeted at two major sites, which is either at the Point of man-vector contact (prevention of infective insect bites) or when the parasite is within the body of the host and is attacked by drugs. The chemotherapeutic approach has taken the fore front in the control scheme for many years. Yet, with the increase in the drug resistant strains (species), other means to combat this disease need serious consideration. Physical barriers, such as bed nets, to reduce man-vector contact and prevent infective bites has been in use for over two thousand years.[3-4] Ross[5] first postulated bed nets as a possible tool of malaria control. Bed nets act as a potentially effective control measure by reducing bites from infected vectors[6-7], its protective ability can be enhanced by treating the nets or impregnation with insecticides.[8] This could serve as an alternative to spraying. Pyrethroid treated nets are now in use to overcome the flaws in ordinary and damaged bed nets.[9-10]

Since the pioneering work of Darriet and others[11], various field trials have been carried out all over the world on the efficacy and effectiveness of insecticide-treated nets (ITN) in malaria endemic countries. In Asia,[12-15] in Latin America[16-17] and in Africa.[18-24] In Nigeria, the first efficacy trial using permethrin ITNs was carried out in Southern Nigeria by Federal Ministry of Health in 1989. Reduction in morbidity and mortality in Nigerian children using ITNs were reported.[25] Low figures among bed net users (with most not being impregnated) was recorded in Nigeria.[26] Generally, ITN coverage remains low in Africa[27-28] with price being a major barrier to the use of ITNs.[29-32] All these trials showed the entomological effects of ITN on malaria transmission, as well as highlighting its greater effects in areas where *Plasmodium falciparum* is prevalent in contrast to *Plasmodium vivax*.[33-34]

The purpose of this survey is to continue the trials on the efficacy of ITNs in Nigeria and to pioneer the work in city centres. Malaria causes illness episodes once or twice a year in close to 50% of the population. Thus, Nigeria loses over N132 billion naira from absenteeism from work, schools, farms and cost of treatment.[35] The cost-effectiveness of insecticide-treated nets in reducing morbidity and

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mortality in malaria endemic countries has been proven.[36-38] Most of the trials the world over focus on rural areas, but there is need to combat the effects of malaria in cities especially with the problems of drug availability[39] and resistance.[40]

Materials And Methods

The Study Area

A randomised field trial of Insecticide Treated Bed-Nets was carried out on the University of Lagos Campus at Akoka, Lagos; the University falls under the Mainland Local Government Area of Lagos State, Nigeria. The University Campus is densely populated and situated at the Lagoon edge (Lagos Lagoon), while it has a slow running canal through it near the gate. The topography consists of grass and shrubs with numerous trees all over. Four hostels were selected for use in the survey trial, namely Jaja, Moremi, Amina and Newest Halls.

Experimental Design

Questionnaires were administered to a total of randomly selected one hundred students, residing in the hostels that had been designated for the trial. The population consisted of fifty males and fifty females ranging from ages eighteen to twenty five years. Questionnaires were administered to seek the students' knowledge on epidemiological factors that affect the spread of malaria. This was followed by collection and examination of blood samples. Three study groups were used to examine the efficacy of the Insecticide-Treated Bed-Nets (ITN), namely Insecticide-Treated Bed-Nets (ITN) group, Un-Treated Bed-Net (UTN) group and Control (CTR) group No Bed-Net.

Insecticide-Treated Bed-Nets (ITN)

A total of sixty bed nets were purchased. The size of the nets were 73"x 64"x 78"(length x width x height) for single beds. Twenty insecticide-treated nets were purchased at the Nigerian Institute of Medical Research (NIMR), while the remaining forty nets, purchased at the local market, were untreated. Lambdocyhalothrin, the synthetic pyrethroid insecticide used to treat the bed nets was purchased in a 25g sachet (ICONETTM; distributed by Syngenta Nigeria Limited, Nigeria). The insecticide was mixed with water to achieve the needed concentration of $0.015g/m^2$(4).

Preparation of Blood Smear

Each week, in the late afternoon or early evening, venous blood was collected from the participants' left hand; usually blood was collected from the middle finger by use of a blood lancet. Two or three drops were taken for use in preparing thick and thin blood films for identification of malaria parasite and parasitemia. The slides were then fixed in methanol and stained in Giemsa. The slides were then examined under a light microscope. This was done using oil of immersion under x100 magnification. The parasites were identified and counted in fields of two hundred WBC (density was calculated by x 8000; parasites/WBC x 8000).

The use of grease free slides and the wearing of protective gloves during the collection and handling of blood was very essential to prevent disease transmission and to provide a hygienic environment.

Results

A total of one hundred students, split into three groups, were examined over a six-week period for malaria parasites. Only *Plasmodium falciparum* trophozoites were observed; the highest parasitemia recorded was in the control and the least was in the ITN. The UTN group (3.75% infected) was generally twice more infected than the ITN group (1.7% infected) and the Control group (11.25% infected) was about 2.5 times more infected than the UTN group (Table I). The results indicates 85% and 67% reduction in parasitemia / malaria transmission for the ITN and UTN groups compared to the control group.

In the ITN group, none of the individuals recorded malaria from week 2 to 5, however in those with untreated nets, the prevalence of malaria increased slightly from week 1 to 3 and then decreased till week 5; with an increase in week 6 (Figure 1). The control group, without any net, recorded significant increase from week 3 to 6 as shown in Figure 1. Only 10% of the males in the first week and 10% of the females in the sixth week had malaria infection in the ITN group while malaria was recorded in both sexes every week except the fifth week in the UT group and more females were infected in the three groups (Table I). The control showed *Plasmodium* infection among the males and females from the first to the sixth week, with very high increase during weeks 5 and 6 (Table I). However, the difference in infection rates between the groups and sexes was not statistically significant ($p > 0.05$).

TABLE I PREVALENCE OF MALARIA BY SEX

us	Week 1			Week 2			Week 3			Week 4			Week 5			Week 6			Total		
	IT	UT	C	IT	UT	C	IT	UT	C	IT	UT	C	IT	UT	C	IT	UT	C	IT	UT	C
e nf)	10	0	5	0	0	10	0	0	0	0	0	0	0	0	20	0	0	20	1.7	2.5	9.2
ıale nf)	0	5	10	0	5	0	0	10	5	0	5	15	0	0	25	10	10	25	1.7	5	13.3
h es nf)	5	2.5	7.5	0	2.5	5	0	5	2.5	0	2.5	7.5	0	0	22.5	5	10	22.5	1.7	3.75	11.25

KEY: IT / ITN – Insecticide-Treated Bed Nets; UT/UTN – Un-Treated Bed Nets; C / CTR -Control

TABLE II MEAN INTENSITY OF THE MALARIA PARASITES IN THE ITN, UTN AND CONTROL GROUPS

STATUS	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
ITN	828	0	0	0	0	588
UTN	867	784	337	591	0	841
CONTROL	1473	650	780	550	512	1061

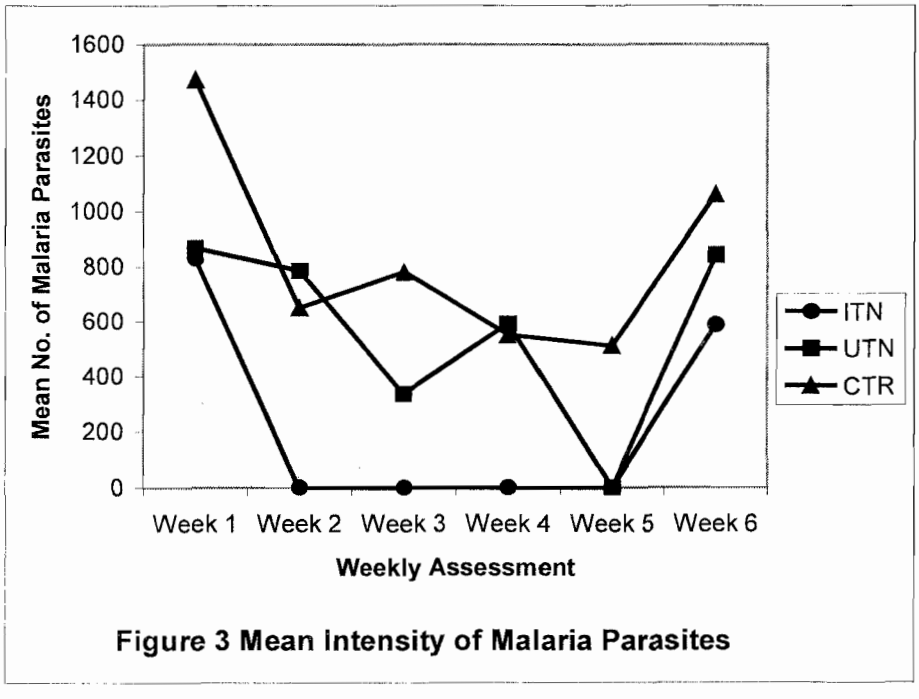

Figure 3 Mean Intensity of Malaria Parasites

KEY: IT / ITN Insecticide-Treated Bed Nets; UT/UTN Un-Treated Bed Nets; C / CTR -Control

All the age groups were susceptible to malaria infection throughout the six weeks study. However, the UTN and the control groups had higher percentages of infected students, as shown in Figure 2. The percentage of those infected increased with age in the UTN group while the level of infection in the control group was almost the same in all the age groups except in age group 22 23 years with lower rate of infection (Figure 2).

In the ITN group, only age group 20 21 and 22 23 years had 2.1% and 1.7% malaria infection

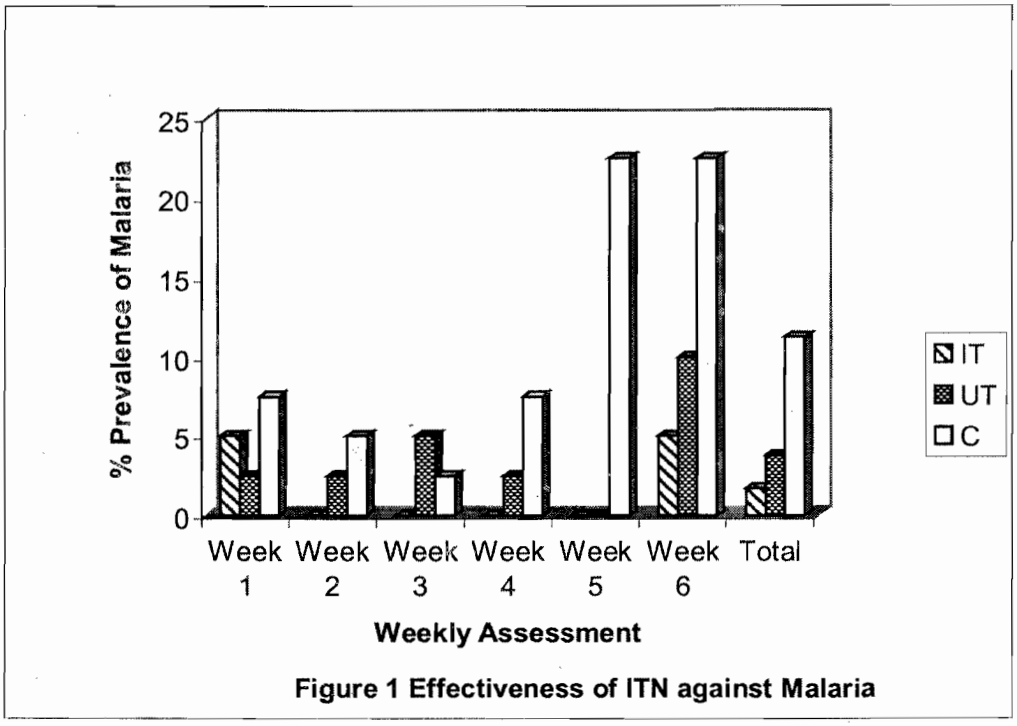

Figure 1 Effectiveness of ITN against Malaria

respectively; no infection was recorded in age groups 18 - 19 and 24 - 25 (Figure 2). In all the age groups, the prevalence of infection increased significantly between the ITN and UTN and between the UTN and the control groups, as shown in Figure 2.

The mean intensity of malaria infection was highest in the control and least in the ITN group (Tables II). In the ITN group, the intensity of malaria infection was zero for 4 of the 6 weeks of study, while in the UTN group, only the 5th week had no record of infection, as shown in Figure 3. In the control group, intensity of infection ranges from 511 1473 (arithmetic mean) for the 6 weeks period of study; parasitemia was recorded every week (Table II).

According to the result of the questionnaires administered, many of the students had used either anti-malarial drugs or were previous bed net users. Nonetheless, some of the treated and bed net users were infected during the survey but not as heavily as the none previous users. The difference in infection level between the previous users and non-users was not statistically significant (p value >0.05).

Discussion

Plasmodium falciparum was recorded as the causative agent of malaria in this study. This is expected as *Plasmodium falciparum* was recorded as the cause of 80% of malaria cases in Nigeria.[35] The World Health Organization[2] also described *P. falciparum* as the number one cause of malaria in Africa. This study presented a basic picture of ITN effectiveness in a city centre; the efficacy of the lambdocyhalothrin-treated bed nets was confirmed, as the UTN group (3.75% infected) was generally twice more infected than the ITN group (1.7% infected) and the control group (11.25% infected) was almost more than 7 times more infected than the ITN group. The results implied 85% and 67% reduction in parasitemia / malaria transmission for the ITN and UTN groups compared to the control group. These results were in line with reports of previous trials and field surveys carried out in the East and West Africa.[11, 41] A reduction in parasitemia and malaria attacks were reported in a field trial in Burkina Faso[41] and the prevalence of *Plasmodium falciparum* was reduced in children in Papua New Guinea[42], due to the effectiveness of insecticide-treated nets (ITN). Another study in Burkina Faso examined the effects of deltamethrin-treated nets in reducing malaria in one-quarter of a savannah village compared with another quarter that did not use nets. The results showed an 82% reduction in malaria transmission because of a lowered sporozoite rate and a decrease in the vector population[4]. In the study carried out in Kenya, hospital admissions for severe and complicated malaria were also reduced by 44% in the group receiving treated nets compared with the control.[43] Various research trials using ITN have demonstrated reductions in child morbidity and

mortality. A review of bed net studies conducted by the UK-based Cochrane collaboration found that the children who slept under treated bed nets were 50% less likely to develop malaria, compared to control groups.[44] It was found in Ghana that not only users of ITN were protected, but there was a 6.7% decrease in child mortality for each 100m shaft away from a home where ITN were used.[45]

The prevalence of malaria was higher among the females compared to males in both the UTN and the control. This may be due to their sleeping habits, the general environment of the female hostels and the reduced level of immunity, possibly as a result of the monthly menstrual flow. The infection recorded in all the age groups showed that all the categories of students used for the study were susceptible except for the protective measures applied. Alternatively, it might be due to prior exposure to mosquitoes outside their rooms and bed nets. The lower level of parasite intensity recorded in this study compared to other trials could be due to the small sample size and the endemic nature of Lagos. The use of only the Giemsa-staining technique instead of the new ParaSight-F dipstick test (PSF) and Immunochromatographic Test (ICT) might have caused a less than accurate detection of parasitemia counts; better methods may be used in future trials in Nigeria.

A lower percentage of students in the ITN and UTN groups were infected, suggesting that a barrier to prevent man-vector contact could be the main tool in malaria control. Although, the treated bed nets provided a greater level of protection against malaria compared to untreated bed nets, untreated bed nets can still play a role in malaria control. The best measure in reducing the prevalence of malaria to zero is by applying integrated preventive measures[46]. The full efficacy of the ITN could have been tested if there had been no UTN group; only the ITN and control, as suggested by Kroeger and colleagues[47]. It could also have been assayed better if the UTN and the control had been placed in different rooms, although this may present its own obstacle of reproducing similar condition for the two study groups. All these factors were taken into account, as much as possible, considering the limited budget for the study.

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