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Effectiveness of Insecticide-Treated Bednets (ITNs) in Malaria Prevention among Children Aged 6 Months to 5 Years in a Rural Community in Imo State, Nigeria

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Abstract: This study sought to ascertain the effectiveness of Insecticide Treated Bednets (ITNs) in malaria prevention among children aged 6 months 5 years in Umungwa Community, Obowo LGA of Imo State. In line with the objectives, 5 research questions and three hypotheses were postulated. A 2 group prospective cohort intervention research design was used. A sample of 100 target children were selected and randomly assigned equally to either the Treated Net (ITN) group or the Traditional Net (TBN) group. Three major WHO validated instruments were used for data collection. Statistical analysis was based on a α 0.05 level of significance. Results showed that: Malaria is endemic in the community, affecting majority of the children; there was no history of bed net use in the community prior to intervention; there was a significant difference in the malaria morbidity situation among the 2 groups studied during the intervention programme ($p<0.05$). As such, ITNS was generally 62.8% more effective in reducing febrile episodes among the two groups; there was a significant difference in the levels of parasitemia among the 2 groups studied during the intervention programme ($p<0.05$). Consequently, the use of ITNs was found to be 84.1% more effective in reducing marked level of parasitemia among the 2 groups; there was a significant difference in the mean mosquito density counts among the 2 groups studied during the intervention programme ($p<0.05$). In line with the foregoing, it is therefore, recommended among other things that: Having established efficacy of ITNs in malaria prevention, a bednet friendly environment should be promoted for example distribution of free or highly subsidized nets and mounting of aggressive community-wide health education campaign to promote culture of ITN use.

Key words: Effectiveness, insecticide, treated bed nets, malaria, prevention, children, rural, community, Imo State, Nigeria

INTRODUCTION

Malaria has always been part of human history for as long as anyone can remember. It is estimated by the World Health Organization (WHO, 2000) that every year, up to 500 million people worldwide suffer malaria attacks, 90% of these are Africans and that there are globally over 2 million deaths yearly-again 90% of these are Africans. In addition, malaria is said to kill one African (whether child or adult) every 15 sec and roughly 300,000 Nigerian children annually (Salako, 2002). Furthermore, as a major cause of ill health in Africa, malaria is responsible for over 10% of the overall African disease burden. People who live below the poverty line, children under five years of age (22% of population) and pregnant women (20% of population) are the most vulnerable to malaria disease (Guillet *et al*., 2001), even where some degree of acquired immunity in areas of intense transmission (stable malaria) for most adult population is offered. However, children are the main victims of malaria particularly in Africa (Bechem *et al*., 1999).

Children (>6 months to 5 years) are especially regarded as non-immunes, when they have lost the immunity (maternal antibody) transferred from their mothers in highly endemic areas (Nwankwo and Uzoma, 2001; Binka *et al*., 1996). Even when surviving children develop their own immunity between the age of 3-5 years, Najera (1989) and Gupta *et al*. (1994), opined that they will still be particularly vulnerable because they had not developed the partial immunity conferred upon surviving repeated infections.

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Current WHO initiatives in malaria control such as Roll Back Malaria (RBM) emphasized the use of Insecticide Treated Nets (ITNs) as one of the key strategies for malaria prevention and control in sub-Saharan Africa (Jones, 2000). It has been suggested however, that ordinary nets provide only partial protection because the nets allow mosquitoes to enter and feed, especially, if the net is even slightly torn or not tucked in properly (Jones, 2000). On the other hand, treating a net with insecticides makes it very effective at repelling and killing anopheles mosquitoes (Salako, 2002; Lines *et al*., 1987). Even when there are holes in the treated nets, Carnevale *et al*. (1992), indicated that the insecticide can affect the mosquitoes as they work their way through. So far, the use of ITNs has led to reductions in child mortality ranging from 14-72% in some African trials (Webster, 2000).

Of great concern therefore, is that beside these huge successes recorded elsewhere in Africa, only a few has been conducted and documented in Nigeria in general and South East in particular where limited health interventions exist. It is against, the background of malaria disease prevention and health promotion among these most vulnerable groups in the rural endemic communities that the researchers were motivated towards ascertaining the effectiveness of ITNs as a malaria prevention strategy among children aged 6 months to 5 years in Umungwa community of Imo State.

The lives of our pre primary school age children (roughly 22% of any given population) are in serious danger from mortality and severe morbidity from malaria attacks (WHO, 2000), if inefficient and ineffective control measures are not put in place mostly at the rural areas. This most vulnerable group, lack the necessary immunity that adults have upon repeated malarial infections and so their chances of survival are 4 times less than that of the adult (Gupta *et al*., 1994). Probably, the greatest concern here is that the use of traditional nets has not produced effective results (Jones, 2000). Moreover, beside of the huge success recorded with ITN trials (Webster, 2000), many of such studies are outside Nigeria, especially the Southeast. Consequently, a lot of people in the area of the present study, have not known much about nets or ITNs, hence this present study.

This study was undertaken to ascertain the effectiveness of Insecticide Treated bed Nets (ITNs) as a malaria prevention and control strategy among the vulnerable group (children aged 6 months to 5 years) in Umungwa Community, in Obowo LGA of Imo State. Specifically, the objectives were to: Determine the general malaria morbidity situation in Umungwa community in Obowo LGA in Imo State prior to the intervention study; to determine the malaria morbidity situation in the area among children 6 months to 5 years age group during the intervention study; to determine the levels of parasitemia among children 6 months to 5 years age group during the intervention study; to determine the mean mosquito density (knock down/blood meal) counts, among children 6 months to 5 years age group during the intervention study and to determine the barrier (s) to present or future use of ITNs in the study area.

Significance of the study: This study has helped to establish the efficacy of ITNs against the ordinary nets in the reduction of malaria morbidity and incidence (among the vulnerable groups) in the area of study. It has also, confirmed that a cost effective, sustainable and replicable malaria control programmes/strategy in the whole LGA, state or elsewhere in Nigeria is possible and feasible. The result of the present study will however, be used to add to the National malaria morbidity and mortality database and to reinforce the need for a community or nation-wide ITN use and adoption currently advocated for.

MATERIALS AND METHODS

A 2 group prospective cohort intervention community trial (Akpala, 1994) of the effectiveness of ITNs as a malaria prevention and control strategy among children aged 6 months to 5 was adopted for the study. Umungwa is one of the larger autonomous communities in Obowo LGA of Imo State, Nigeria. The major dependent variable was any observed difference in malaria morbidity, levels of parasitemia or mean mosquito density count among the different study groups. However, the major independent variables of the study were the 2 different study groups that were randomly assigned to either the treated bednet group or the traditional bednet group The study lasted 4 months between June and September, 2006, which was considered fair enough to observe the impact indicators (e.g., No. febrile episodes, level of parasitemia and mean mosquito density). The study was designed in 2 groups of one experiment and one control, such that only observed difference between groups can be attributed to the real effect of the ITNs. Another major feature of this design was that the 2 groups were to be as alike as possible in all respects except in nets (Kroeger and Press, 1995) e.g., at onset of intervention, all 2 groups were within the same age group and cleared of any level of parasitemia. Thus, efficacy was measured as the proportion of the malaria cases or levels of parasitemia or mean mosquito density in the control group that would not have occurred had they slept under treated nets. The

Table 1: Statistical test of significant difference in malaria morbidity among children in ITN and TBN groups

Exposure groups	No. of children having febrile illness episode after the intervention programme: D^+ febrile conditions	D^- no febrile conditions	Total	Success in malariam orbidity prevention (%)
E+ TBN group* n = 50	43 (a)	7 (b)	50 a+b (k)	7/50 (14%)
E^- ITN group* n = 50	16 (c)	34 (d)	50 c+d (L)	34/50 (68%)
Total	59 a+c (m)	41 b+d (n)	100 (m) a+b+c+d	Total Success Rate = 68-14 = 54%

A: Relative Risk (RR) = 2.7 (ITN = 0.32; TBN = 0.86); B: Total Success Rate (TSR) = 54% (ITN = 68%; TBN = 14%); C: Attributable Risk (AR) = 0.54 (ITN = 0.32; TBN = 0.86); D: Attributable risk (%) = 62.8%; E: Effectiveness of ITN = 62.8%; F: χ^2 = 30.136; df = 1, $\chi^2 \propto 0.05 = 3.841$; $p<0.05$; *E+ = Positive exposure factor; *E- = Negative exposure factor

Table 2: Statistical of significance difference in the levels of parasitemia among children in ITN and TBN groups after intervention

Exposure groups	Levels of parasitemia after intervention: Marked MP count >1 MP μL^{-1}	Insignificant MP <1 1 MP μL^{-1}	Total	TSR in having reduced MP level (%)
E+ve TBN group n = 50	44 (a)	06 (b)	50 (k)	06/50 =0.12 = 12 a+b
E+ve TBN group n = 50	07 (k)	43 (d)	50 (l)	43/50 = 0.86 = 86 c+d
Total	51 a+c (m)	49 b+d (n)	100 (M) a+b+c+d	TSR = 0.86 -0.12 = 0.74 = 74%

A: Relative Risk (RR) = 6.3 (TBN = 0.88; ITN = 0.14); Total Success Rate (TSR) = 74% (TBN =0.12%; ITN = 0.86%); Attributable Risk (AR) = 74 (TBN = 0.88; ITN = 0.14); Attributable Risk Percent (AR%) = 84.1%; Effectiveness of ITN = 84.1%; Chi-square (χ^2) = 54.782; $X^2 \propto 0.05 = 3.841$; df =1; $p<0.05$

target population comprised all pre school children (6 months to 5 years) in the community calculated with 22%, comprising percentage of children <5 years in any given population (Guillet *et al.*, 2001), the study expected about 1, 100 children <5 years. To obtain a statistical results with a 95% confidence interval (or a 5% level of significance) and a power of 80%, a minimum sample size of 100 children was required, which were assigned randomly into either the experimental or control groups. Three major research instruments were used for data collection namely: Household morbidity survey and impact indicator schedule used to ascertain the current malaria morbidity situation as well as the mosquito density count; Malaria Parasite (MP) assay data entry sheet used to assess levels of parasitemia during the intervention and Bed nets (treated and traditional). Only the Lambda-Cyhalothrin based Pyrethroid insecticide treated bednet among other varieties of insecticide, was used for the study (Miller and Curtis, 1999). The validity of these instruments (i) and (ii) were structured according to guide lines established by the World Health Organization (WHO) and have also been used for data collection in some other similar previous studies (Rasheed *et al.*, 2000), with resounding and positive results while, that of (iii) rested with its already endorsement by WHO after previous WHO efficacy trials (Jones, 2000). The instruments (i and ii) were pre tested (with 10 copies each) on similar subjects in a neighboring town to Umungwa. Ten days after, a repeat survey was conducted (for instrument 1). For instrument 2, the repeat test was done in the evening of same day. A pre test result of 0.7 and 0.8 obtained in respect of instruments 1 and 2, respectively were considered reliable estimate for usability of the instruments (Davitzs, 1997). Expected extraneous variables that may otherwise invalidate results such as (time of net assignment and compliance: Clearance of levels of Parasitemia; application of other control measures; training of mothers on local diagnosis of febrile episodes as well as data entry) were controlled. Trained research assistants effectively monitored the intervention. At end of the 4 month intervention period, another MP test was conducted (Giemsa technique) on all target children. Data generated through the instruments (i and ii) were sorted and coded manually and later analyzed using the EPI INFO version 6.1 statistical package in other to produce the basic frequencies and test of statistical significance for the variables under study. For the hypotheses in particular, the following test statistics were utilized based on the nature and type of data generated such as: relative risk; total success rate; attributable risk; effectiveness of intervention; Chi-square (χ^2) test and student t-test of means.

The observed impact indicators were the No. of febrile episodes, level of parasitemia and mean mosquito density.

Malaria morbidity in this case was judged by the number of febrile episodes experienced by the vulnerable groups as against their use of either a Traditional Bed Net (TBN) or Insecticide Treated bed Net (ITN). However, when the data were further subjected to chi square (χ^2) statistic test, to see if there would be any significant difference in the malaria morbidity situation among the 2 groups, the result was very significant ($p<0.05$) (Table 1).

Table 2 reveals the analysis of the test of significant difference in the levels of parasitemia through an MP (Malaria parasite) assay conducted on the target children after the intervention programme. Two criteria for judging the levels of parasitemia were: >1 MP uL^{-1} of blood regarded as marked MP and <1 MP uL^{-1} of peripherial blood interpreted as no or insignificant presence of MP.

Table 3: Test of difference in the mean mosquito density among the TBNs and ITNs groups

	Measures of difference in mosquito density among the 2 groups of study				
Exposure groups	Total mosquito density in all households for 4 months	Density or attack rate per child in household for 4 months	Success of bednet in reducing attack rate (Density)	Effectiveness of ITN	t-test
TBN group p1	2827	56.5 (74.0)	19.8%	100 (1-p1/p2)	n =50 X =706.8 SD =168.6
ITN group p2	988	19.8 (25.9%)	56.5%	64.9%	n =50 X =247 SD =150.9
Total n = 100	3815	76.3 (100.0%)	Total success due to ITN =56.5-19.8 =36.7%		t =14.217 $t_{\propto 0.025}$=1.980 $p<0.05$

Mosquito Attack Rate (AR) =74.0% (TBNs); 25.9% (ITNs); Attack Rate Reduction (ARR) = 48.1%; Total Success Rate (TSR) = 36.7%: SR (ITNs) =19.8% SR (ITNs) = 56.5%; Effectiveness of Intervention with ITN = 64.9%; t-test of difference in mean mosquito density = 14.217; $t_{\propto}$ 0.05/2 (2 tail) = 1.980; df = 98; $p<0.05$

Again, when the data were further subjected to chi square (χ^2) statistic test, to see if there would be any significant difference in the level of parasitemia among the two groups studied, during the intervention programme, the result was found to be very significant ($p<0.05$) (Table 2).

Mean mosquito density was measured as total blood meal (±) mosquitoes caught (in the intervention group) or total knock down mosquitoes caught (in the control group) throughout the four months period of intervention. (Table 3). Table 3 was further subjected to a student t-test statistic, which at the 0.05 level of significance, this result was found to be statistically significant ($p<0.05$) indicating a difference in the mean mosquito density counts among the 2 groups studied.

RESULTS

Table 4 presented a summary of findings from results as floated:

- Mosquito attack rates or density among the two groups (Table 3). The Relative Risk (RR) of having febrile episodes in children <5 years increased by 2.7 times in children with TBNs than those with ITNs (Table 1).
- ITNs appears to be 54% better in preventing febrile episodes in target children (Table 1).
- The risk reduction attributable (AR) to use of ITNs in the intervention was 0.54, meaning that in every 100 childhood febrile cases, there would be a reduction by 54 cases when ITNs are used (Table 1).
- The incidence risk of 0.86 (86%) of febrile episode among children in TBN group would have been futher reduced by 62.8%, if they had used ITNs (Table 1).
- ITN generally proved to have 62.8% effectiveness in making a difference in reducing malaria morbidity situation among the 2 groups (Table 1).
- There was a significant difference in the malaria morbidity situation (febrile episodes) among the 100 studied vulnerable children during the intervention programme ($p<0.05$) (Table 1).
- The Relative Risk (RR) of having a marked (increased) MP count increased as high as 6.3 folds in children with TBNs as against those using ITNs (Table 2).
- The use of ITNs appears to be 74% better than use of TBNs in its ability to cause a reduced levels of parasitemia among the target children (Table 2).
- The risk reduction attributable (AR) to use of ITN in the intervention was 0.74, meaning that in every 100 MP assay test conducted, there will be a reduction by 74 cases when ITNs are used (Table 2).
- The incidence risk of having marked (increased) level of parasitemia of 0.88 among TBN users would have been further reduced by 84.1% had they used ITNs (Table 2).
- The use of ITNs was 84.1% effective in causing a reduction in marked level of parasitemia among the 2 groups (Table 2).
- There was a significant difference in the levels of parasitemia among the 100 studied vulnerable children during the intervention programme ($p<0.05$) (Table 2).
- A reduction in mosquito density or attack rate of 48.1% would have occured if TBN users had used ITNs (Table 3).
- Use of ITNs appears to be 36.7% better than that of TBNs in repelling/knocking down mosquitoes, thereby reducing mosquito density (Table 3).
- Giving similar situations, ITNs use will reduce mosquito density and subsequent attack rate in the entire community by 64.9% (Table 3).
- There was a significant difference in the mean mosquito density counts among the 100 studied vulnerable children during the intervention programme ($p<0.05$) (Table 3).

Table 4: Break down of summary of results

	Table/hypothesis		
Measurement/statistic	HO_1	HO_2	HO_3
Relative Risk (RR)	2.7 TBN = 0.86 ITN = 0.32	6.3 TBN = 0.88 ITN = 0.14	--
Total Success Rate (TSR)	54% TBN = 14% ITN = 68%	74% TBN = 0.12% ITN = 0.86%	36.7% TBN = 19.8% ITN = 56.5%
Attributable Risk (AR)	0.54 TBN = 0.86 ITN = 0.32	0.74 TBN = 0.88 ITN = 0.14	--
Attributable Risk (AR%)	62.8%	84.1%	--
Attack Rate (AR)	--	--	74% (TBN) 25.9% (ITN) Attack rate reduction = 48.1%
Effectiveness of ITN Per attribute	62.8%	84.1%	64.9%
Significant test @ $\propto$0.05 level	$\chi^2 = 30.136$ $p<.05$ $p<0.05$	$\chi^2 = 54.782$ $p<.05$ $p<0.05$	t-test = 14.217 $p<0.05$

DISCUSSION

The implications of the major findings generated form analysis of the data are presented and discussed under the following subheadings:

Results related to malaria morbidity (*Febrile episodes*) among subjects during the intervention programme (HO_1): After the baseline survey, subjects were then randomized into two groups, Insecticide Treated bed Net (ITN) and Traditional Bed Net (TBN). The subjects were subjected to 2 MP assay tests (Giemsa stain MP test and a second, Qualitative buffer coat-QBC-confirmatory MP test). The essence according to Parzy *et al*. (1990), Rickman *et al*. (1989) and Payne (1988), was to confirm and clear up any parasite in the peripheral blood of subjects, such that they enter the intervention with zero level of parasitemia. Again, it was designed to ensure that any observable difference in the impact indicators (febrile episodes, levels of parasitemia, mosquito density) would be ascribed to the effect of the intervention. The reasons are that febrile illness in association with plasmodium parasitemia is considered malaria illness when no other cause of the fever can be identified. Breman and Steketee (1992), held the view that excluding other potential causes of fever might be difficult in many settings, particularly in the developing countries, where the case definition of malaria illness could lack both sensitivity and specificity (Table 1 and 4).

The intervention revealed that out of the 100 subjects, 59 children suffered febrile episode. Of this number, few episodes 16 (27.1%) were experienced by the ITN group, while more episodes 43 (72.9%) were experienced by children in the TBN group. The use of nets in preventing febrile episodes for the 2 groups showed that the risk of having febrile episodes increased by 2.7 times in TBN children than in ITN children (Relative risk = 0.86 TBN; 0.32 ITN; Table 4). Use of ITN as against TBN appeared to be 54% better in preventing febrile episodes in subjects, such that the incidence risk of 0.86 in TBN group would have been further reduced by another 62.8%, had they slept under an ITN. This result also yielded a total effectiveness for ITN of 62.8% in febrile episode reduction among the target children. To this end, there was found to be a significant difference in the malaria morbidity situation among the stated vulnerable groups of the study ($p<0.05$). This result was expected, because according to WHO (undated), large scale use of ITNs has been accompanied by substantial reductions in malaria incidence. To buttress this, Kroeger and Press (1995) conducted a study on incidence of ITN at 5 different malarious areas of Ecuador, Colombia and Peru between 1991 and 1994. The study recorded an average febrile episode protection of 40.8%, at a 4 month data of clinical malaria incidence. Similarly, in a randomized control trials on 325 households in Savalou region, North of Cotonou in Benin between April 1994 and March 2995, Rashed *et al*. (2000), submitted that the use of ITNs decreased the risk of febrile episodes by 34% in rural children.

Other studies to compare the efficacy of ITN over TBN in preventing malaria, such as that conducted by D'Alessandro *et al*. (1995) in Gambia children aged 6 months to 5 years documented a high reduction in malaria infection and low parasitemia among treated net users than in controls. Similarly in Nigeria, a study was conducted by Brieger *et al*. (1990) and (1997), where children <5years resided in 12 village clusters in Nsukka LGA. of Enugu state. The study observed a statistical difference ($p = 0.004$) in malaria prevalence between ITN children and other groups (Insecticide curtains, Residual sprays and their controls).

Resulted related to levels of parasitemia among subjects after the intervention programme (HO_2): Malaria parasites have over the years been used as proxy indicator of malaria infection because according to Breman and Steketee (1992) the diagnosis of malaria in a febrile patient is confirmed by the identification of malaria parasites on blood smear or samples in addition of course to clinical presentation. This is so because plasmodium infection is defined as the presence of the parasites in the peripheral blood of an individual (Parzy *et al*., 1990). In this study, marked level of parasitemia was calculated as counts of more than one parasite μL^{-1} of blood (>1MP μL^{-1}). Again Breman and Stekette (1992) had already admitted that febrile illness in association with plasmodium parasitemia was considered malaria illness, who no other cause of the fever could be identified (Table 2 and 4).

Two MP assay tests (pre and post treatment), were conducted to ensure that all subjects entered the study (at beginning of intervention) with zero level of parasitemia, so that any observable difference after the intervention might be attributable to the effect of the intervention. At the end of the 4 months intervention, another MP test (Giemsa technique) was conducted. Results (Table 2) indicated that less children in the ITN group (7/50 or 14%) had a marked MP level (>1MP μL^{-1}), while more children in the TBN group (44/50 or 88%) had a marked MP level (>1MPμL^{-1}). This result was expected, because according to previous researches, such as the one conducted on a large scale spraying of bed nets to control malaria infection in Sichuan, China from 1987-1995 (Cheng and Heng, 1995). The result of that study showed that by passive surveillance of reported cases, mass blood surveys of school children and active surveillance of reported blood slides from fever cases, all indicated marked reduction compared with the controls.

Use of nets in having a reduced level of parasitemia for TBN and ITN groups (Table 2), produced results that showed that the relative risk of having marked MP level increased as high as 6.3 folds in TBN users than in ITN group (RR = 0.88-TBN; 0.14-ITN). Use of ITNs proved 74% better in having a reduced MP level than TBNs, because the result further revealed that had the TBN children used ITN, the incidence risk of 0.88 would have been further reduced by 84.1%. In addition, the overall effectiveness of 84.1% was achieved for ITNs use in reducing a marked level of parasitemia among target children. In a similar, field trial of Permethrin Impregnated Bednets (PIBs) study conducted in 2 Afghan refugee villages in Pakistan (Rowland *et al*., 1996), microscopy records showed that 22.4 and 13.0% controls became infected with *P.vivax* and *P. falciparum*, respectively while in the intervention group only 9.9% contracted P.vivax (RR = 0.58) and only 3.8% of intervention contracted *P. falciparum* (RR = 0.39).

Table 2 also revealed a statistical significant difference in levels of parasitemia among ITN and TBN groups after the intervention. Marked MP count was found among 7 in 50 subjects (ITN group) and 44 in 50 subjects (TBN group). This result was expected because it already corroborated with previous studies such as that conducted by D'Alessandro *et al.* (1995). Their study that compared the efficacy of ITN and TBN in preventing malaria among sampled Gambian children aged 6 months to 5 years and documented a high reduction in malaria infection and low parasitemia at the end study.

Results related to the mosquito density count among subjects after the intervention programme (HO_3): Mosquito caught with or without (±) blood meal (TBN group mostly) or those knocked down (ITN group mostly), were used as proxy measures of mosquito density in this study. A total of 3815 mosquito counts were recorded throughout the 4 months duration of intervention. At the end of intervention (Table 3) a total of 988 mosquitoes (Attack rate = 19.8; Density = 26.0%) were caught in the ITN group, while 2827 mosquitoes (Attack rate = 56.5; Density = 74.0%) were caught by the TBN group. Significantly, there was a marked decrease in the mosquitoe density among ITN group (32.0 June; 29.0 July; August 19.0 and 16.0 September). The trend in this result was expected. It has been suggested however that ordinary traditional bed nets provided only partial protection, since according to Salako (2002) and Jones (2000), if the net was even slightly torn or not tucked in properly, then mosquitoes might enter and feed on humans sleeping in them. Conversely, treating nets with insecticides makes it effective at repelling and killing *anopheles* mosquitoes for 6-12 months because of the deterrent and excito-repellant effects and feeding inhibitions of the insecticides (Salako, 2002; Lines *et al*., 1987). Again, it has been demonstrated (Salako, 2002; Carnevale *et al*., 1992) that when there were holes in the treated nets, the insecticide could affect the mosquitoes as they research their way through. Because of these repellant effects of the insecticides, one can explain the reasons for the marked decrease in mosquito density among ITN group in the study. In line with the above submission, Cheng and Heng (1995) carried out a bed net study in China from 1987-1995. Results indicated a marked reduction in the biting populations and survival of the 2 vector species (*A. anthrophagus* and *A. sinsensis*) (Table 3 and 4).

However, the use of nets in reducing mosquito density among the 2 groups in this study after intervention (Table 3), yielded for the ITN group a reduced attack rate and mosquito density (19.8 and 26.0%, respectively), obviously because of the repellant effect claimed previously of the insecticide. As such, the attack rate among subjects would have been further reduced by 48.1%, if they had used ITNs. The result also, revealed that ITNs were 36.7% better in repelling mosquitoes or reducing mosquito density in the study area. Further calculations indicated that ITN was 64% effective in reducing mosquito density in the study area. In line with these findings, Kroeger and Press (1995), conducted a bed net study at 5 different malarious areas in Ecuador, Colombia and Peru. At end of study, the protective efficacy of the treated nets against controls varied in each of the 5 areas between 0-70% at post intervention. Similarly studies in 1998 in Ouagadougou (capital of Burkina Faso) on randomly selected houses from 158 villages that were netted at different intervals with impregnated curtains in all doors and other openings. Results indicated that vector densities reduced to <1 bite/person/night inside intervention area, compared to 3-10 bite/person/night outside the intervention area (Iboudo-Sanogo *et al*., 2001).

The result in Table 3 finally documented a statistically significant difference in the mean mosquito density among the ITN and TBN groups, respectively ($p<0.05$; $t = 14.217$; $t\alpha$ 0.0 5 = 1.980). Similarly, in an already cited bed net study in Nsukka area of Nigeria (Brieger *et al*., 1997, 1990), the mean scores of intervention in preventing mosquito bites were 1.93 (treated bed net), 1.74 (insecticide curtains) and 1.64 (Residual spraying), p = 0.000047. Still on bed nets and mosquito density, it was reported that in an insecticide trial (using different strengths and types) in Dar Es Salaam, Tanzania, conducted by Miller *et al.* (1999), people who had regularly slept under a net noticed that the presence of a treated net had a marked effect on mosquitoes and other insects in the room. Those who were given placebo nets (treated only with water) complained that these nets were no different from their usual ones.

Since, replication of sound scientific and empirical study is welcome in public health, the findings in this study has well corroborated with results previously obtained in past but similar researches. Hence, there is stronger need more than ever before to reinforce the importance of adoption of ITNs as a malaria prevention and control strategy among rural endemic communities by health educators.

CONCLUSION

The study is constrained to conclude the following based on the findings generated through statistical analysis thus: That malaria is endemic in the area of study. ITNs proved more effective than did TBN in reducing number of febrile episodes among the vulnerable target children during the period of intervention. Again, ITNs was more effective than TBNs in causing a reduction in marked level of parasitemia among the vulnerable target children during the period of intervention. Equally, ITNs was more effective than TBNs in reducing markedly mosquito density and subsequent attack rate among the vulnerable target children during the period of intervention. In summary, this study has helped to establish the efficacy of ITNs against the ordinary nets in the reduction of malaria morbidity and incidence (among the vulnerable groups) in the area of study. It has also confirmed that a cost effective, sustainable and replicable malaria control programmes/strategy in the whole LGA, State or elsewhere in Nigeria is possible and feasible. The result of the present study will however be used to add to the National malaria morbidity and mortality database and to reinforce the need for a community or nation-wide ITN use and adoption currently advocated for.

Study implications: The results and conclusions drawn form this study obviously have great implications for public health. Results indicated that ITNs was more effective than TBNs considering the three impact indicators of this intervention study. Even when efficacy in one trial is established, it is emphasized that such alone is not the criterion to confirm overall long-term effectiveness of a particular insecticide. Moreover, different mosquito species have according to previous research, responded or even resisted some types of insecticides giving longer exposure. Since, the duration of this study was short, one may not really like to make a generalization until studies of longer duration are replicated. This will enable a comprehensive operational observation to be made on both vector behavior and vector resistance to insecticides used.

Limitations: The researchers in the course of this study experienced three obvious limitations and they include: Inability of some mothers to differentiate mosquitoes with blood meal from the caught or knocked down mosquitoes. Most mothers also lacked the skill for correct net installation while some flouted some rules by wearing long pants and sleeves on their children before sending them to sleep. Some mothers also, were identified as administering treatment to their children without even informing the principal investigator, the supervisors or even to record it on their daily record sheets as instructed.

The insecticide/vector interaction however, is not very clear at present and the relevant information is inadequate. More information is therefore needed. All these provided a basis for casting some elements of doubt on the internal validity of the results of this present study and therefore call for caution on its reproducibility.

RECOMMENDATIONS

On the strength of the findings the researchers are constrained to recommend as follows:

- The government of the day should help to promote a bednet friendly environment or society by embarking on free distribution of bednets or distributing them at highly subsidized rates.
- Government can also through appropriate agencies remove the tariffs on importation of nets or insecticides, so that poor masses can afford them.
- Again, the government can also through the appropriate medium like the electronic or print media, mount a community wide aggressive campaign to promote culture of net use.
- Since, there has been this expressed renewed fear for mosquito resistance to the insecticides (just as it happened in drug resistance), there should be a renewed concern more than ever before for a search for a malaria vaccine.

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