The effect of insecticide treated bed net use on malaria episodes, parasitaemia and haemoglobin concentration among primigravidae in a peri-urban settlement in southeast Nigeria

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Abstract

Between 80-90% of the world's malaria cases occur in sub Sahara Africa and approximately 19 -24 million pregnant women are at risk for malaria and its adverse consequences. The major impact of Malaria in pregnancy has severe negative effects on maternal health and birth outcomes including maternal anaemia, high incidence of miscarriages and low birth weight. Primigravidae and secundigravidae are most at risk. Due to increased and spreading malaria parasite resistance to first line antimalarials like chloroquine and sulphadoxine–Pyrimethamine in sub-Saharan Africa, the available tools for malaria control in pregnancy are now very limited. One of the most commonly used tool for preventing malaria in pregnancy is insecticide treated bed nets (ITNs), which have been shown to reduce the number of infective mosquito bites by 70-90% in a variety of ecologic settings. In Nigeria, the current use of ITNs among pregnant women and children under 5 years, is just 1%, according to the Nigeria Demographic and Health Survey (NDHS).

This study aimed at examining the effects of the use of ITNs on episodes of uncomplicated malaria, frequencies of malaria parasitaemia and anaemia among two hundred and eight primigravidae. The design was an analytical case control. One hundred and four subjects received ITNs between August 2003 and January 2004 and the other 104 subjects acted as controls. Data were obtained using the new World Health Organization antenatal care classifying form and the basic component checklist, and a structured interviewer-administered, 30-item questionnaire. Laboratory tests were done to obtain data on episodes of malaria, levels of malaria parasitaemia, mean haemoglobin concentration and anaemia.

The results in test group showed 28.9% and 20% reduction in episodes of uncomplicated malaria and in frequency of malaria parasitaemia at 38 weeks gestation, respectively. However, there was no difference in mean haemoglobin concentration and in frequency anaemia between the test and control groups. The use of ITNs by primigravidae in this peri-urban settlement in south eastern Nigeria, showed significant reductions in episodes of uncomplicated malaria and malarial parasitaemia.

Keywords: ITN, Malaria, Primips

Introduction

Malaria is a serious health care problem in tropical and subtropical regions of the world with far-reaching medical, socio-economic consequences for the countries in which it is found. Each year approximately about 300 million malaria episodes and 2.5 million deaths are reported worldwide with 80% of them occurring in sub-Saharan Africa. In endemic areas, clinical episodes and mortality are more frequent and severe among pregnant women than non-pregnant (D'alessandro et al 1996). In these areas pregnant women generally remain asymptomatic despite sequestration of parasitised erythrocytes in the placenta microcirculatory system. In contrast, in unstable malaria transmission areas, pregnant women are prone to severe malaria (Singh et al 1999, Kochar et al 1998).

Many studies have proved that placental malaria is associated with low birth weight and increased neonatal mortality, and that this association is demonstrated only in first pregnancies. Pregnant women with parasitaemia are susceptible to anaemia and hypoglycaemia (Kochar et al 1997, Mc Gregor 1984, Steketee et al 1988). In the Gambia, Bray and Anderson (1979) observed that pregnancy caused an increase in prevalence and density of *Plasmodium falciparum*. Redd et al (1996) found that the highest parasite densities were observed in primigravidae and secondigravidae with a progressive fall in density as parity increased. The increase in malaria prevalence and density was at its peak early in the second trimester and decreased over the second half of pregnancy but there was no increase in malaria occurrence at parturition and with age.

In other surveys (Bray and Anderson 1979, Verhoeff 1999) in rural Malawi, it was observed that peak prevalence of malaria in the post rainy season period, were highest in primigravidae, followed by secondigravidae, and multigravidae.

Bouvier et al (1997) reported a higher prevalence of anaemia and severe anaemia among primps in Kenya. Severe anaemia was more than twice as common in women with peripheral parasitaemia than in aparasitaemic women, and parasitaemia was associated with a decrease in mean haemoglobin level in primigravidae. *P. falciparum* malaria infection was strongly associated with moderate and severe anaemia (Gilles et al 1969, Sulhman et al 1996)

In Nigeria, Okonofua et al (1991), working at Ile-Ife, found an overall 27% prevalence of malaria parasitaemia in pregnant women and observed that the effect of gestational age on the rate of parasitaemia was highest in mid pregnancy in both primigravidae and multigravidae, although the parasite rate declined significantly towards the end of pregnancy.

Okonofua et al (1991) also reported that the prevalence of cord malaria parasitaemia was significantly higher among newborn babies of primigravidae than those of two or more pregnancies. The mean birth weights of newborn babies with parasitised cord blood were found to be generally lower than those with no parasitised cord blood. In addition, they observed that the birth weights of newborns with infected cord blood also decreased with increasing parasite densities.

Malaria burden among on pregnant women and their children has renewed efforts on community preventive measures which include intermittent preventive treatment and Insecticide-Treated-Nets (ITNs) for pregnant women. To evaluate the potential of ITNs, efficacy trials were carried out in countries with a wide range of transmission intensities in Africa, Asia, Latin America and the Western Pacific on all cause child mortality, incidence of severe malaria, incidence of uncomplicated malaria episodes, prevalence of parasitaemia, mean haemoglobin level etc (D' alessandro et al 1995, Malaria foundation International 2003, Cochrane library Review 2003, CDC 2004). It was concluded that ITNs are effective at reducing malaria in children and adults

However, (Ter Kuile et al 1999) reported that women in their first to third pregnancies living in insecticide treated bed net villages were significantly less likely to become anaemic compared to those living in control villages (WHO 2003). In Nigeria, the current use of ITNs to prevent adverse consequences of malaria infection among pregnant women and children under 5 years, is just 1%, according to the Nigeria Demographic and Health Survey (NDHS).

This study aimed at examining the effects of the use of ITNs on episodes of uncomplicated malaria, frequencies of malaria parasitaemia and anaemia among two hundred and eight primigravidae.

Methodology

Study area

Okpoko is a peri-urban slum settlement in Ogbaru local government area of Anambra State, Southern-East Nigeria. It has a population of low-income earners comprising mostly traders, artisans and farmers living with their families. Population density is high while housing facilities are poor and mainly bungalows; low in height, with wooden windows and doors, each room having only one door and one window. There is poor lighting in the rooms with poor ventilation. This provides ideal hiding and resting places for mosquitoes after a blood meal. There are also bushes in between groups of houses. There are ditches and gutters created by erosion over the years. Pot-holes riddle almost all of the untarred roads. The few available drains which do not flow are filled with refuse, and the intervening bushy, empty plots serve as refuse disposal sites, and defecation places, as most of the bungalows have inadequate or no toilet facilities. In this situation of very low environmental sanitation and poor personal hygiene, infective diseases abound. This environment predisposes this community to the scourge of malaria disease with children less than five years of age and pregnant women, particularly primigravidae being the most at risk.

Study design

For the purpose of this study, the World Health Organization (WHO) Ante Natal Care (ANC) model was used by the four participating hospitals. For standardization, the investigators provided the W.H.O. ANC. model (IDRC 2003) to all the hospitals and trained both the doctors and their nurses on the concept and its practice. These were further rehearsed before the study started.

A doctor in each hospital along with the already trained nurses and research assistants carried out the registration activities daily as the subjects enlisted for antenatal care, using the WHO model forms. The study procedure, aims and objectives and what was expected of each subject was explained. Then, the

individual consent form was read out and explained to the subject, who either signed or thumb printed after which the questionnaire was applied.

Ethical consent was obtained from the ethical committee of the Nnamdi Azikiwe University Teaching Hospital.

Study subjects

The population of Okpoko by the 1991 census figures is about 105,127 - males and females. Females only are 50,167. The study subjects were 208 primigravidae pooled from four randomly selected privately owned hospitals situated in the study area. One hundred and four consecutive primigravidae were recruited and given ITNs and instructions on the use of nets. The recruitment of the intervention group continued until the 105th primigravida that became the first subject in the control group. The same process was followed for the control group that did not receive ITNs.

This procedure adopted in recruitment of subjects into the two groups was necessary for the following reasons: All those that used the nets would use them about the same season of the year. It would also be easier to monitor and supervise ITN users together. This also helped us to use the successes of some to teach and encourage others. It helped in preparing many nets at the same time; saving time, materials and cost.

Each subject had a file containing her ante natal records, WHO classifying form, individual consent form and questionnaire. Subjects belonging to the intervention group had their files marked “plus ITNs” while controls did not bear this mark. Both groups were given SPas IPT by directly observed treatment (D.O.T). This was given as two doses of 3 tablets per dose. First dose was given in the second trimester and the second dose in early third trimester. Subjects that had confirmed episodes of malaria illness received treatment irrespective of their group. Both groups also received routine antenatal drugs package of haematinics, two doses of three tablets of Levamisole at three monthly intervals and at least two doses of Tetanus Toxoid vaccine.

One hundred and thirty family size nets, made to WHO specifications, were treated according to manufacturer’s instructions. The subjects were given the nets and taught on use and care for them. Subjects were encouraged to sleep under the nets every night from when they received the nets till they delivered and thereafter.

Subjects were specifically questioned about their use of the bed nets at each antenatal care clinic attendance. During the study period, impromptu random home visits were carried out to ascertain the extent of use of the nets. All those visited were using their nets.

Data Collection and analysis

Data collection was done using an interviewer administered non validated questionnaire, the WHO antenatal forms, obtaining blood and urine samples from subjects as and when due. All antenatal and laboratory data were collected and collated and manually entered onto spreadsheets in a numerical order. Then all the questionnaires were collected and also numbered to tally with that on the spreadsheet. All these were cross -checked with the original records to correct any errors. These data were entered into the computer and processed using EPI INFO version 6.04, WHO/CDC application software.

The initial data exploration was done by examining the frequency distribution of all variables. Data cleaning including necessary corrections were made on the data set. The descriptive statistics such as frequencies and percentages were used to describe the categorical variables, while the summary statistics such as mean and standard deviation were used to summarize the numerical variables. The

Chi-square test was used to compare two categorical variables for possible relationship. Where comparison of two categorical variables did not show a definite relationship, as was the case with malaria parasitaemia between the intervention and control groups, a comparative analysis of differential decrements was applied. All statistical tests were carried out at 0.05% level of significance; at 95% level of confidence. Statistical power of the study was 80%.

Results

Two hundred and eight (208) primigravids were enrolled. 104 of these used ITNs, (intervention group), while the remaining 104 did not use ITNs (control group). Both groups satisfied the set inclusion criteria for the study.

A total of 11 subjects had problem with hanging their nets. They were visited and helped out. Two others refused to allow their husbands to sleep under the net with them; but were encouraged to share with their husbands and they did. Five had no beds in their rooms. They were shown how to hang the nets low enough to cover them while they lay on their mats on the floor.

Of the 104 in the intervention group, 99 (95.2%) delivered in the designated hospitals but 5 did not. Of the 104 in the control group, 91 (87.5%) delivered in the designated hospitals while 13 did not. This difference in response between the two groups can be explained by the fact that the intervention group that received I.T.Ns showed more commitment to the study than the control group that did not receive I.T.Ns. However, all the subjects that defaulted did so after their 38 weeks appointment. Therefore, data for all variables in the study, except pregnancy outcomes, were obtained from all 208 subjects in the two groups.

The mean ages for the intervention and control groups (mean ± SD) were 24.79 ± 4.29 and 24.84 ± 5.99 respectively. Socio-demographic characteristics for both the intervention and control groups were similar (Table 1).

Table 1: Socio-demographic characteristics and gestational ages of study groups

Study factors	Intervention Group N (%)	Control Group N (%)
Age in years		
15- 19	11 (10.6)	9 (8.6)
20- 24	37 (35.5)	38 (36.6)
25- 29	44 (42.3)	47 (45.2)
30- 34	11 (10.6)	9 (8.6)
35- 39	1 (1.0)	1 (1.0)
Mean Age ± SD	24.79 ± 4.29	24.84 ± 5.99
Education		
No formal education	1 (0.9)	6 (5.8)
Primary education	8 (7.7)	11 (10.6)
Secondary education	92 (88.5)	85 (81.7)
Post Secondary education	3 (2.9)	2 (1.9)
Occupation		
Trader	53 (51.0)	56 (53.9)
Housewife	37 (35.6)	37 (35.6)
Clerk	8 (7.7)	4 (3.8)
Teacher	6 (5.7)	7 (6.7)
Tribe		
Igbo	102 (98.1)	104 (100)
Hausa/ Fulani	1 (0.95)	0 (0)
Efik	1 (0.95)	0 (0)
Religion		
Christianity	104 (100)	104 (100)
Marital status		
Married	100 (96.2)	101 (97.1)
Single	4 (3.8)	3 (2.9)
Gestational Age (Trimesters)		
1st	17 (16.4)	24 (23.1)
2nd	57 (54.8)	52 (50.0)
3rd	30 (28.8)	28 (26.9)
X^2 = 1.49 P > 0.10		

Only 16.4% in the intervention group and 23.1% in the control group registered in their first trimester. (Table 2)

Table 2: Knowledge, attitude and use of mosquito bed nets and ITNs (Before study)

Group	Intervention %	Control %
Knowledge of Mosquito bed nets(MBN)	85.6	90.4
Usage of MBN	20.4	38.5
Knowledge of ITN	0	0
Attitude towards ITN		
Desire to own	98.1	96.2
Preferred distribution channel		
Health facility based	88.5	94.2
Church based and others	11.5	5.8

There was a high level of disparity between the awareness of mosquito nets and its use at home. None of the subjects in the intervention and control groups knew about or used ITNs before the study. X^2 = 1.00, P>0.30. Ninety-eight percent (98.1%) of subjects in the intervention group and 96.2% in the control group desired to own and use ITNs after they were initially informed about the use and benefits.

In their response to preferred channel of distribution, 88.5% in the intervention group and 94.2% in the control group preferred health facility based distribution (Table 2)

Eighty–six primigravidae (prevalence rate of 41.3%) had at least one episode of uncomplicated malaria. Twenty-five percent of the intervention group had 1 episode of malaria from registration to 38 weeks, while only 1.9% had 2 episodes. 73.1% had no malaria episode at all. However, among the control group 49.1% had 1 episode of malaria while 6.7% had 2 episodes. Only 44.2% had no malaria episodes at all. Overall 26.9% had malaria episodes among the intervention group while 55.8% had malaria episodes in control group. This shows 28.9% reduction in malaria episodes in the intervention group compared with the control group; P<0.003, (Fig 1)

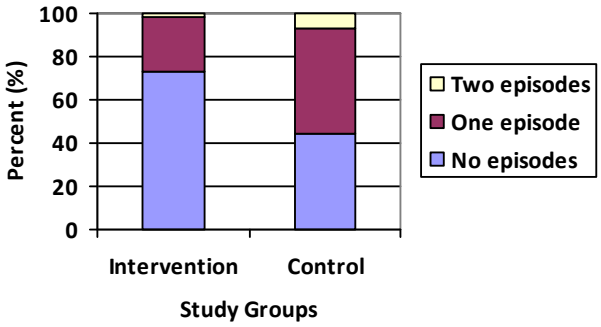

Figure 1: Malaria episodes in intervention and control study groups from registration to 38 weeks gestation.

At registration (pre-ITN distribution), prevalence of parasitaemia among all the subjects was 48.1%; At 38 weeks, after the introduction ITNs, prevalence of parasitaemia among the control group only was 23.4%, while among the intervention group prevalence was 0%. Therefore reduction in parasitaemia in the control group was only 26.6% while in the intervention group it was 46.2%. (Fig 2)

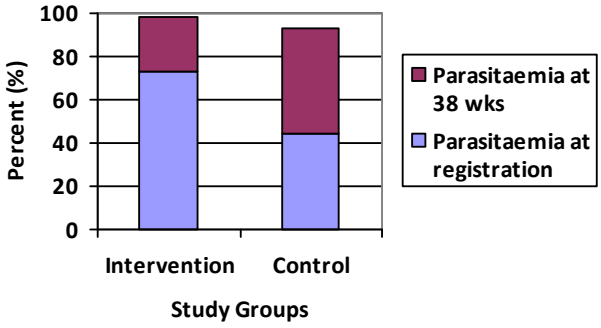

Figure 2: Malaria parasitaemia at registration and at 38 weeks gestation in intervention and control study groups.

On comparing the overall mean haemoglobin concentration for the two groups at registration and at 38 weeks; both groups had an increase of 0.6 g/dl. (10.7 minus 10.1 g/dl for the intervention group and 10.5 – 9.9 g/dl for the control group).

The frequency of anaemia among subjects in the two groups was compared; at registration, 46.2% of intervention subjects were anaemic as compared with 52.9% of controls. At 38 weeks, 19.2% of intervention subjects were anaemic when compared with 20.2% of the controls. Therefore at 38 weeks, 25.0% of subjects in the intervention group had their anaemia corrected, while 32.7% (52.9% - 20.2%) occurred in the control. After ITN.s use, fewer primigravidae in the intervention group had anaemia than in the control (Table 3).

Table 3: Mean haemoglobin (hb) concentration and frequency of anaemia among subjects at registration and 38 weeks.

Mean Hb concentration	Intervention group		Control group	
	At registration N= 48	At 38 weeks N= 20	At registration N=55	At 38 weeks N= 21
Overall mean	10.1 ± 1.12	10.7 ± 1.0	9.9 ± 0.90	10.5 ± 0.87
Mean at Anaemia level≤ 10g/dl	9.1 ± 0.606	9.3 ± 0.444	9.23 ±0.560	9.21 ± 0.561
Frequency of Anaemia (<10g/dl)	46.2%	19.2%	52.9%	20.2%

Discussion

This study compared the number of malaria episodes, frequency of malaria parasitaemia, levels of haemoglobin and frequency of anaemia, in 104 primigravidae that used ITN.s, with those of another 104 primigravidae that did not use ITNs. The present study showed statistically significant reduction ($p< 0.003$) in the number of episodes of uncomplicated malaria with the use of ITNs. by primigravidae. It also showed statistically significant reduction ($p<0.004$) in malaria parasitaemia; these findings agrees with those of similar studies in other parts of the world (D' alessandro et al 1995, Abdulla et al 2001, Feiko et al 2003, WHO 2003). All the studies so far considered had values higher than values in the present study both in malaria episodes (28.9%) and malaria parasitaemia (20.0%). The low figures in the present study may be accounted for by the late registration of most of the subjects. Studies have shown that the risk of peripheral malaria parasitaemia is greatest in the first 20 weeks of pregnancy, with malaria rates at delivery approximating the levels in the postnatal period and those seen in non-pregnant women (Feiko et al 2003). Another possible explanation for the low values in this study is that the 2 doses of IPT given to all the subjects, contributed to the low percentages for levels of parasitaemia in both groups at 38 weeks. Studies have shown that two treatment doses of S.P. given to pregnant women in areas of high transmission of malaria, even without symptoms, can significantly reduce the negative consequences of malaria during pregnancy and also reduce both peripheral and placental parasitaemia (Parise et al 1998, FMOH 2004). Again, the use of ITNs in this study was based on individual or family barrier protection only. Other studies involved villages or whole communities, thus combining individual barrier protection effect with the community or mass effect in ITNs on vector populations and sporozoite rates. This increased the efficacy of ITNs and so reduced parasitaemia to lower levels in those that used them, thereby increasing the differential figure between users and non-users. There are studies, however, which produce no significant advantage for pregnant users of ITNs. There may be some confounding factors in these studies that made the results so completely at variance with results from the other studies. Such factors may include type of study design, for example, cluster randomisation has a greater potential for bias, because of the limited number of assignment units, than clinical trial design based on randomisation by individual (Feiko et al 2003)

Impact of ITNs on levels of Haemoglobin and Frequency of Anaemia.

Similarly, there was no statistically significant reduction (5.7%) in the frequency of anaemia in the intervention group (25.0%) compared with the control group (32.7%). Therefore, in both mean haemoglobin concentration and frequency of anaemia; ITNs use by the primigravidae did not make any significant useful impact in this study. These findings agree with those from previous studies (Okonofua et al, 1991, Singh et al, 1999, Verhoeff, 1999, WHO, 2003). However, some authors hypothesize that in higher transmission settings, like Nigeria, or where there are prolonged seasons of P.falciparum transmission, ITNs alone do not prevent the adverse effects of malaria in pregnancy. (Feiko et al 2003). There could be other causes, though unknown, that might explain the observed differences in the various studies. Findings from previous and present studies showed that others

factors apart from ITN use account for maternal heamoglobin concentration and consequently maternal anaemia. However it should be stated that the beneficial impact of ITN use is more pronounced, when used early in pregnancy (first half) during which malaria prevalence and density are at their peaks.

In conclusion, use of ITNs by primigravidae in Okpoko, a peri - urban slum in south eastern Nigeria, showed significant reductions in episodes of uncomplicated malaria and malarial parasitaemia, but no impact on mean haemoglobin concentration, anaemia. Health facilities involved in the care pregnant women should be encouraged to integrate IPT and ITN distribution into their antenatal care schedule.

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