Effect of the use of insecticide-treated bed nets on birth outcomes among primigravidae in a peri-urban slum settlement in South-East Nigeria

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Abstract

Introduction

Each year in sub-Saharan Africa, where 80 to 90% of the world's malaria cases occur, approximately 19 to 24 million women are at risk for malaria and its adverse consequences during pregnancy. The major impact of malaria during pregnancy in these regions is caused by persistent or recurrent, predominantly low-grade, sometimes sub-patent, parasitaemia. In Nigeria, malaria has severe negative effects on maternal health and birth outcomes, resulting in maternal anaemia, a high incidence of miscarriages and low birth weight. Primigravidae and secundigravidae are most at risk.

Resistance to first-line antimalarials has increased in sub-Saharan Africa, and the available arsenal of alternative tools for malaria control in pregnancy is very limited. One of the most promising of these tools is insecticide-treated bed nets (ITNs), which have been shown to reduce the number of infective mosquito bites by 70 to 90% in a variety of ecologic settings. In Nigeria, the current use of ITNs by the at-risk groups, pregnant women and children under five years, is just 1%, according to the latest report of the Nigeria Demographic and Health Survey (NDHS).

Aim

TThis study aimed at examining the effects of the use of ITNs on pregnancy outcomes among 208 primigravidae.

Methodology

The study design was an analytical case control. One hundred and four subjects, the intervention group, received ITNs between August 2003 and January 2004. The other 104 subjects were the control. Data were obtained using the new World Health Organization antenatal care classifying form and the basic component checklist, and a self-structured, 30-item pre-tested questionnaire. The Apgar scores of the babies and their birth weights were observed and recorded for both the intervention and the control groups.

Results

The results showed that 83% of babies of mothers in the intervention group had a good condition at birth, while 87% of babies of mothers in the control group had a good condition at birth ($p>0.07$; X2=1.69). A small increase in mean birth weight (0.001kg) of the babies of mothers in the intervention group was observed over those of mothers in the control group ($p>0.90$). This showed that there were no significant beneficial impacts of the use of ITNs on foetal condition at birth, mean birth weight and low birth weight.

Conclusion

The use of ITNs by primigravidae in Okpoko, a peri-urban slum in south-eastern Nigeria, showed no significant impact on pregnancy outcome.

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Introduction

The threat posed by malaria as a public health problem is increasing worldwide. It has proved intractable, and the disease has rearmed itself to re-emerge in an even more frightening form, namely as resistant to erstwhile very effective, easily available and affordable drugs: chloroquine and sulphadoxine/pyrimethamine (SP).[1] The spread of chloroquine resistance and the low adherence to antimalarial prophylaxis during pregnancy has led to the reconsideration of the role of antimalarial prophylaxis in controlling malaria in pregnancy.[2]

According to Chukwuani, the control of falciparum malaria is becoming increasingly challenging in many endemic areas of the world, including Nigeria, due to the development of resistance to chloroquine and other antimalarial drugs.[3]

The malaria burden in Africa is heavy. As many as 550 million people are at risk, especially in areas of stable transmission. Stable malaria exists in Nigeria, where there is perennial transmission of malaria parasites. The intensity of attack remains constant all year round.

Malaria increases the risk of adverse pregnancy outcomes, including abortions, premature births, stillbirths and low birth weights.[4] In endemic countries, pregnant women are four times more likely to suffer malaria attacks – causing low birth weight babies and stillbirths – than their non-pregnant counterparts. Nearly 60% of miscarriages are due to malaria.[5]

Malaria has severe negative effects on maternal health and birth outcomes in Nigeria. It causes maternal anaemia and increases the incidence of miscarriage and low birth weights. The prevalence of malaria among pregnant women in Nigeria was 48% in 2000 and 2001 according to Federal Ministry of Health (FMOH) figures.[6]

In areas where *P. falciparum* is endemic, pregnant women are at increased risk of malaria, and this risk is greatest during the first pregnancy. This increased susceptibility of pregnant women to malaria is thought to be due either to sequestration of the parasites in the placenta or to depression of selected components of the immune system in association with increased production of several hormones or other proteins.7,8,9,10

One of the resolutions of the African Summit on Roll Back Malaria in Abuja is that "by the year 2005 at least 60 per cent of those at risk of malaria, particularly pregnant women and children under five years of age, benefit from the most suitable combination of personal and community protection measures such as ITNs and other interventions which are accessible and affordable to prevent infection and suffering".[11]

Intermittent preventive treatment (IPT) consists of two treatment doses of antimalarials, for example sulphadoxine and pyrimethamine (SP), given to all pregnant women in areas of high transmission, even when they have no symptoms, during their second and third trimesters of pregnancy. This has been shown to significantly reduce the negative consequences of malaria during pregnancy. Even one dose of SP has been shown to significantly reduce placental malaria.[12] In a study in Malawi, Verhoeff ***et al.*** noted that two doses of SP compared with a single dose in pregnancy resulted in a reduction in the incidence of low birth weight from 33.9% to 13.5% in primigravidae.[13] In their study in Kenya, Shulman ***et al.*** compared IPT with SP and with a placebo and found a significant decrease in severe anaemia in pregnant women on SP, but not in those on the placebo. However, there was no significant difference in the occurrence of low birth weight between the two groups.[14]

Schultz ***et al.*** showed a significant impact of the two-dose sulphadoxine/pyrimethamine regimen on peripheral and placental parasitaemia and a tendency towards a higher mean birth weight and a lower percentage of low birth weight babies.[15]

The introduction of insecticide treated nets (ITNs) by the World Health Organization (WHO) as one of its key strategies for the prevention and control of malaria seems to offer some hope in winning the battle against malaria.[16] Studies conducted on the use and efficacy of ITNs and curtains in the malaria-endemic areas of the world have shown that ITNs actually deter mosquitoes from entering the room. Even a treated net with large holes in it provides as much protection as an intact one, reducing mosquito bites by up to 95%.[17] ITNs were perceived to be as effective in reducing mosquito bites as insecticide-impregnated curtains and residual spray by communities that used them in Nsukka, Nigeria.[18]

Although IPT with SP has been found to be safe and efficacious for the prevention of malaria in pregnant women,[12] sleeping under ITNs remains an important strategy for protecting pregnant women and their newborns from malaria-carrying mosquitoes.[19]

Recent large-scale studies in Kenya, Ghana and the Gambia have also proved that the innovative use of ITNs is a highly effective method for controlling and preventing the spread of malaria.[17] ITNs can be reused by re-impregnating them with fresh permethrine insecticide. Therefore, they are expected to be less expensive in the long term than other preventative methods. This method is also simple and safe and can be organised and conducted locally by lay persons.[17]

In addition, Dolan ***et al.*** reported a strong association between ITN use and prematurity and low birth weight. In their study, pre-term births were reduced in the ITN group by 40%.[20] However, the studies by Shulman ***et al.*** in Kenya and Browne ***et al.*** in Ghana showed no significant benefit in pregnancy outcomes with ITN use among pregnant women.[21, 22]

The incidence of low birth weight, and low birth weight combined with stillbirths, abortions and intrauterine growth retardation, were significantly reduced by 28% and 25% respectively in parities 1 to 4.[23]

Mean birth weights, the prevalence of parasitaemia at 32 weeks of gestation, and the percentage of premature babies were significantly different in primigravidae living in villages where bed nets had been treated with permethrine insecticide.[24]

Placental parasitaemia is more common than peripheral parasitaemia. 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.[25, 26]

In the Gambia, Bray ***et al.*** observed that malaria apparently inhibited the passage of maternal anti-malarial IgG across the placenta to the foetus, thus reducing protection against malaria to infants during the first month of life[24].

Bouvier ***et al.*** investigated the impact of malaria on low birth weight in Mali.[27] The authors observed that parasitaemia measured during pregnancy was associated with lower birth weight in infants from first and second pregnancies, but not from mothers of a higher pregnancy order. They therefore concluded that malaria in pregnancy has an important negative impact on birth weight in first and second pregnancies.[27]

In another study, Egwuyenga ***et al.*** observed that 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.[28] They therefore concluded that there was a need for more efficient malaria chemoprophylaxis during antenatal care in public hospitals to manage malaria in pregnancy, and thereby reduce the incidence of low birth weight.

In yet another study, Parise ***et al.*** showed a significant impact on mean birth weight and the percentage of low birth weight babies. They found that IPT with SP is safe and efficacious for the prevention of placental malaria in pregnant primigravidae and secondigravidae in sub-Saharan Africa.[12]

The aim of this study is to ascertain the difference, if any, in birth outcomes between those of primigravidae using ITNs and those not using ITNs.

Methodology

This study lasted for a period of fifteen months, from August 2003 to October 2004.

Study area and study population

Okpoko is a peri-urban slum settlement in the Ogbaru Local Government Area adjoining the commercial city of Onitsha. The population of Okpoko comprises low-income earners, mostly traders, artisans and farmers, living with their families. The population density is high, while housing facilities are deplorable. Generally, four to six adults with children share a room of about 3.5 m by 4.0 m. This overcrowding encourages the high transmission of malaria. In the main, the houses are poorly built bungalows. The lighting and ventilation are poor and provide ideal hiding and resting places for mosquitoes after a blood meal. There are also bushes between groups of houses, interspersed by ditches and gutters created by erosion over the years. Potholes 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.

Sampling

The estimated population of primigravidae in Okpoko in 2003 was 495. Based on the chosen study design of an analytical case control study, with an expected response rate of 90%, a test of differences in proportion was used, considering alpha (α) and beta (β) errors. A sample size of 208, 104 in each group, was estimated to be needed for sufficient power.

Subjects, materials and methods

The study subjects comprised 208 primigravidae pooled from four randomly selected, privately owned hospitals that are situated in the study area.For the purpose of this study, the World Health Organization (WHO) Ante-natal Care (ANC) model was used by the four participating hospitals. For standardisation, the WHO ANC model was provided to the four hospitals, while the doctors and their nurses were trained in the concept and its practice. The use of the instrument was rehearsed in two workshop formats before the study started.[18]

A total of two hundred and eight (208) primigravidae were registered in the four hospitals. The 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. During recruitment, the WHO ANC forms were explained to each subject, as well as the study procedure, the aims and objectives and what was expected of the subjects. The individual consent form was then read out and explained to the subject, who either signed or thumb printed. This was followed by the questionnaire being administered.

Selection of subjects

The first 104 consecutive subjects who registered were placed in the intervention group and given ITNs prepared in the hospitals the previous day. They were taught how to hang and care for the nets. The 105th subject who registered became the first subject in the control group. These subjects were not given ITNs. This continued until another 104 subjects had been enlisted. This procedure was necessary for the following reasons:

- All those who used the nets would use them for about the same season of the year
- It would be easier to monitor and supervise all those using ITNs 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 costs.

Each subject had a file containing her antenatal records, WHO classifying form, individual consent form and questionnaire. Subjects belonging to the intervention group had their files marked "plus ITNs", while the controls did not bear this mark.

All the subjects were placed on sulphadoxine/pyrimethamine (SP) as intermittent preventive treatment (IPT) given by directly observed treatment (DOT), two doses of three tablets per dose in the second and early third trimester.

Both groups also received a routine antenatal drug package of haematinics, two doses of three tablets of levamisole at three-monthly interval and at least two doses of tetanus toxoid vaccine. Subjects who had confirmed episodes of malaria illness received treatment irrespective of their group.

One hundred and thirty family-sized nets made to the United Nations Children's Education Fund (UNICEF) standards were treated according to the manufacturer's instructions. The subjects were given the nets and taught how to hang them over their beds in their homes. They were encouraged to sleep under the nets every night from when they received the nets until they delivered and thereafter.

The subjects were specifically questioned about their use of the bed nets at each ANC clinic attendance. A total of 11 subjects experienced problem hanging their nets. They were visited and helped. Two others refused to allow their husbands to sleep under the net with them, but they were encouraged to share with their husbands, which they then did. Five (5) 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.

During the study period, two impromptu, random home visits were carried out, a week after issuance of nets and at 36 weeks gestation, to ascertain the extent of use of the nets. All those visited were using their nets.

The condition of the babies at birth was observed using the Apgar scoring system.[29] The evaluation was made at one minute after birth, and again at five minutes. The birth weights of the babies were measured using instruments for weighing infants.

Data collection, management and statistical analysis

Data collection was done using an interviewer-administered, non-validated questionnaire, the WHO antenatal forms, and obtaining blood and urine samples from the subjects as and when due. All antenatal 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 the necessary corrections, was made on the data set. 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 summarise the numerical variables. The Chi-square test was used to compare two categorical variables for any possible relationship. Where the comparison of two categorical variables did not show a definite relationship, a comparative analysis of differential decrements was applied. All statistical tests were carried out at the 0.05% level of significance at a 95% level of confidence. The statistical power of the study was 80%. Ethical consent for the study was obtained from the Ethics Committee of the Nnamdi Azikiwe University Teaching Hospital.

Results

Of the 104 in the intervention group, 99 (95.2%) delivered in the designated hospitals but five 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 ITNs showed more commitment to the study than did the control group, which did not receive ITNs. However, all the subjects who 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.

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

Age (years)	Intervention group N	%	Control group N	%
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	1.0	1.0	1.0	1.0
Mean age (Mean ± 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	103	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				

The mean ages for the intervention and control groups (mean ±SD) were 24.79 ± 4.29 and 24.84 ± 5.99 respectively. Table I shows the age distribution of the intervention and control groups. The majority of the subjects had attained a secondary education: 88.5% of the intervention group and 81.7% of the control group.

Concerning the occupation of the subjects, the majority were traders and housewives. Almost all the subjects were Igbos, and all were Christians. Only seven out of the 208 subjects were single.

A total of 16.4% of subjects in the intervention group and 23.1% in the control group registered in their first trimester (see Table II). A high level of awareness of mosquito bed nets was recorded among the primigravidae – 85.6% in the intervention group and 90.4% in the control group. The difference between these two groups was not statistically significant – $X^2 = 1.14$, $P > 0.2$ Table II).

However, there was a low level of use of bed nets in the homes: 20.4% in the intervention group and 38.5% in the control group. None of the subjects

Table II: Knowledge of, attitude to 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 Church based and others	88.5 11.5	94.2 5.8

in the intervention and control groups knew about or used ITNs before the study (X^2 = 1.00, P>0.30). Ninety-eight per cent (98.1%) of the 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. Only 1.9% in the intervention group and 3.8% in the control group did not desire to own and use ITNs. After counselling, the two primigravidae in the intervention group that said "NO" to the desire to own and use ITNs accepted and did use them.

In their response to the preferred channel of distribution, 88.5% in the intervention group and 94.2% in the control group preferred distribution through health facilities, while 11.5% in the intervention group and 5.8% in the control preferred other channels, such as church, school and open market sale (see Table II).

In the intervention group, 82.8% of babies born were in a good condition at birth, while 86.7% in the control group were in a good condition. There were three intrauterine deaths (IUDs) in the intervention group, while the control group had no IUDs (see Table III).

There was a small increase in mean birth weight (0.001kg) between the intervention group and the control group. However, this difference is not statistically significant (see Table IV). Among the 99 infants born to intervention mothers, 11.1% were <2.5 kg, while 15.4% of the 91 infants born to the control mothers were <2.5 kg.

Table III: Foetal condition at birth

Foetal condition at birth	Intervention N	%	Control N	%	Total
Good = Apgar score ≥ 7 at 1 minute	82	82.8	79	86.7	161
Resuscitated = Apgar score ≤ 6 at 1 minute	14	14.2	12	13.3	26
IUD (still birth)	3	3.0	0	0	3
Total	99	100	1	100	190

X^2 = 1.69; P>0.07

Table IV: Mean birth weights (MBW) of infants born to study primigravids

Mean birth weight (kg)	Intervention N = 99	Control N = 91
MBW ± SD	3.316 ± 0.397	3.315 ± 0.429

Z- score =0.017; p> 0.90; n =number of births.

Discussion

This study compared the conditions of babies at birth and the birth weights of babies of 104 primigravidae that used ITNs with those of another 104 primigravidae that did not use ITNs. All the subjects lived in Okpoko, a peri-urban settlement in Anambra State, South-eastern Nigeria. The subjects were monitored from the time of booking to delivery.

Findings from the study showed that the socio-demographic characteristics of the subjects in the two groups did not differ significantly, and so did not influence or affect the results as confounding factors.

Impact of ITNs on pregnancy outcomes

In this study, no beneficial effect of ITN use on foetal condition at birth was demonstrated. There was a minimal increase (1 gm) in mean birth weight (MBW) of babies born to the intervention mothers over those of babies born to the control mothers. The increase was not statistically significant (p>0.9). Therefore, there was no benefit of ITNs regarding mean birth weight. Although there were fewer low birth weight (LBW) babies (11.1%) in the intervention group than in the control group (15.4%), this difference was not statistically significant. Therefore, there again was no benefit of ITN use on the frequency of low birth weight.

These findings agree with those of previous studies.[21,22,23] The study by Shulman ***et al.*** in Kenya showed no significant benefit from the use of ITNs on pregnancy outcomes, including mean birth weight and low birth weight.[22] Also, the study by Browne ***et al.*** in Ghana showed no significant benefit to both mean birth weight and low birth weight in babies born to ITN women.[23] Dolan ***et al.*** carried out a study in three refugee camps on the Thai-Burmese border. The study did not reveal any beneficial effect of ITNs on birth weight.[21]

However, in a study done in Gambia by D'Alessandro ***et al.*** during the rainy season, there were fewer pre-term deliveries among women who used ITNs than among those who did not. The mean birth weight of children born in ITN villages was 130 g higher than the weight of children born in control villages.[30] In their study, Ter Kuile ***et al.*** showed significant improvements in low birth weight and other adverse pregnancy outcomes like abortion, intra-uterine growth retardation and stillbirths.[31]

Considering all the results of all the studies reported here, it is obvious that the results from the present study are consistent with some and at variance with others, the type and design of study used notwithstanding. There could be causes other than ITN use that might explain the observed differences. However, two factors that were observed to have had profound effect on lowering the values obtained in the present study need to be emphasised.

First is the gestational age at which the subjects were booked. Almost 84% of those that used the ITNs booked in their second and third trimesters, meaning that the majority of the subjects started the use of the ITNs halfway through their pregnancy. This also means that they used the nets for half of the period they ought to have used them. Besides, studies have shown that the risk of peripheral malaria parasitaemia is greatest in the first 20 weeks of gestation.[1] Bray ***et al***., in the Gambia study, observed that an increase in malaria prevalence and density was at its peak early in the second trimester, and decreased over the second half of pregnancy.[23] Therefore, the short duration of the use of ITNs markedly reduced the period of protection against the adverse effects of malaria, which consequently reduced the extent of the beneficial effects of ITN use.

Second is the use of IPT, a proven effective tool in malaria prevention and control in pregnant women. For example, Verhoeff ***et al.,*** working in Malawi, showed that two doses of sulphadoxine-pyrimethamine compared with a single dose in pregnancy resulted in a reduction in the incidence of LBW from 33.9% to 13.5% in primigravidae.[24]

Rogerson ***et al.*** recorded that women taking two or more doses of SP deliver babies 195 g heavier than women not taking SP.[32]The use of IPT in this study so improved the health status of the control group that it tended to blunt the very beneficial impact of ITN in the intervention group. The importance of these two limiting factors was highlighted by the Kenyan study, which noted that additional studies were required to delineate the role of individual versus community effect, and the impact of malaria control programmes in pregnancy that use single interventions versus programmes that combine the benefits of IPT with ITN.[1] Although the use of IPT reduced the extent to which the effects of ITNs were shown in the variables in this study, it is still recommended as one of the effective tools for the prevention and control of malaria in pregnancy.

In conclusion, it would appear that ITN use has a varied impact on birth outcomes among pregnant women. Some studies have revealed significant beneficial impact on mean birth weight and the frequency of low birth weight in babies of pregnant ITN users over pregnant non-users, while other studies have revealed no significant beneficial impact. This variation in findings is attributable to many other factors that contribute to low birth weight, including poor nutrition, anaemia, medical conditions such as hypertensive disorders (pre-eclampsia, eclampsia in pregnancy), and other infections like helminthiasis.

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