International Journal of TROPICAL DISEASE & Health
23(3): 1-17, 2017; Article no.IJTDH.33848
ISSN: 2278–1005, NLM ID: 101632866

SCIENCEDOMAIN *international*
www.sciencedomain.org

Use of Insecticide-treated Net and Malaria Parasitemia in Under-fives at National Hospital Abuja

Temiwoluwa M. Omole[1*], O. Ogunfowokan[1] and Akin Moses[1]

[1]Department of Family Medicine, National Hospital Abuja, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author OO supervised this research work and made substantive intellectual contributions right from the 'conception' of the study topic through proposal writing, carrying out the study, analysis to the final write-up. Author AM helped in the conceptualisation and 'fine-tuning' of the research topic. Author AM supervised the work and provided regular oversight through the different stages of the work. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2017/33848
Editor(s):
(1) Zhiheng Zhou, Thyroid Cancer Research Laboratory, Massachusetts General Hospital, Harvard medical school, Boston, USA.
Reviewers:
(1) Oluwagbemiga Olanrewaju Aina, Nigerian Institute of Medical Research, Nigeria.
(2) Rajendra Maharaj, Medical Research Council, South Africa.
Complete Peer review History: http://www.sciencedomain.org/review-history/19408

Original Research Article

Received 1st May 2017
Accepted 2nd June 2017
Published 8th June 2017

ABSTRACT

Aim: To determine the relationship of ITN utilisation with malaria parasitemia in under-five children attending the General Paediatric Outpatient Department (GPOPD) in National Hospital Abuja (NHA), as well as, explore factors that affect use / non-use of ITNs, so as to give informed education on ITN use to caregivers of children attending the clinic.
Study Design: Cross-sectional study.
Place and Duration of Study: GPOPD, Family Medicine Department of NHA between April 2014 and July 2014.
Methods: Three hundred and eighty (380) children aged between 6 and 59 months were recruited into the study using systematic sampling. Data about caregivers' and children's socio-demographic characteristics, knowledge about malaria and ITNs, preferred malaria control method, ownership of ITNs or lack thereof, problems encountered when using ITN, sleeping arrangements, and source of mosquito net, were collected using an interviewer-administered questionnaire. Data analysis was

**Corresponding author: Email: temi.omole@gmail.com;*

done using Epi-info version 7 statistical software. Level of significance was set at 0.05. Ethical approval was given by the Research and Ethics Committee of NHA. Written informed consent was obtained from all recruited patients.

Results: The level of ITN ownership was 57% (216 of 380) while the level of ITN utilisation was 30% (115 of 380) which revealed a clear gap between ITN ownership and utilisation. The prevalence of malaria parasitemia was 40% (95% CI 35.1 - 45.1%). The log mean parasite density was 2.14 ± 0.48. There was no statistically significant association between ITN use and socio-demographic characteristics of child and care-giver (age, gender, highest educational qualification, social class, housing structure), knowledge of the cause of malaria, as well as their perception of ITN effectiveness. Among those with malaria parasitemia, there was no statistically significant difference in the parasite density of ITN users and non-users.

Conclusion: A clear gap exists between ITN ownership and utilisation. Also, there was a lack of any statistically significant relationship between ITN use and malaria parasitemia in under-fives within this study setting.

Keywords: Under-fives; insecticide-treated net use; malaria parasitemia.

1. INTRODUCTION

There is no doubt that there has been steady progress in combating malaria globally. Despite this, current indices show that it still constitutes a major health problem, particularly in sub-Saharan Africa. The World Health Organisation (WHO) documented that malaria transmission was still ongoing in 91 countries and territories worldwide. The World Malaria Report 2016 estimated that 212 million cases of malaria occurred globally in 2015 with 429 000 deaths. Malaria case incidence and mortality rates have however declined by 41% and 62% respectively since 2000 [1]. Malaria transmission occurs in all WHO Regions (African, Region of the Americas, South-East Asia, European, Eastern Mediterranean, and Western Pacific) but the African Region, particularly the poorest and most vulnerable populations, bears the brunt of this disease accounting for an estimated 92% of malaria deaths with 70% of all deaths occurring in children aged under-five years [1]. In 2015, the number of malaria deaths in under-five children was estimated to have decreased by 29% since 2010, but malaria still remains a major cause of death in children, killing a child every two minutes [1].

Malaria is endemic in Nigeria whose climatic conditions make it suitable for perennial malaria transmission. About 85% of Nigerians live in areas of meso-endemic transmission while 15% live under conditions of hyper-holoendemic transmission. Nigeria is one of the 6 countries that account for 60%, or 390 000, of malaria deaths. Others are: the Democratic Republic of Congo, Burkina Faso, Mozambique, Cote d'Ivoire, and Mali. As part of global efforts to stem this endemic tide, the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP), the World Bank and the World Health Organization (WHO) joined forces in the "Rollback malaria initiative" (RBM) in 1998 and later, a 2nd generation Global Malaria Action Plan "Action and Investment to defeat Malaria (AIM) – for a malaria-free world" was drawn up. Its focus remains on global advocacy, resource mobilisation, partner harmonisation and the engagement of non-health sectors for the implementation of the technical strategy [2]. Malaria interventions are effective and affordable. These include vector control via insecticide-treated net (ITN) usage or indoor residual spraying (IRS); chemoprevention and case management (diagnosis and treatment) [1]. The use of insecticide-treated bednets (ITNs) remains one of the main malaria prevention strategies, particularly in areas that require sustained vector control, e.g the majority of sub-Saharan African countries including Nigeria, majority of Asian malaria-endemic countries and some American countries. Since 2007, WHO has recommended universal coverage with ITNs (preferably LLINs), rather than a predetermined number per household. In order to meet the target of universal access, it is currently proposed that one LLIN should be distributed for every two persons [3]. In sub-Saharan Africa, an estimated 53% of the population at risk slept under an ITN in 2015 (95% confidence Interval CI: 50-57%), compared to 5% in 2005 and 30% in 2010 (95% CI: 28-32%) [1]. A total of 214 million nets were projected to be delivered to countries in sub-Saharan Africa by the end of 2014, bringing the total number of LLINs delivered to that region since 2012 to 427 million [1].

Despite these efforts, ITN use particularly in the vulnerable population, remains low. The 2015

Nigeria Malaria Indicator Survey (NMIS) estimated that 44% of children were using ITNs [4], which is still way below the RBM target of 80% use for children [5]. It is however encouraging that there was a 27% increase from the figure (17%) documented in 2013 and this relative progress is documented on the global front as well. According to the World Malaria Report (WMR) 2016, the estimated proportion sleeping under an ITN for countries in sub-Saharan Africa was 53% in 2015 (95% CI: 50-57%), increasing from 30% in 2010 (95% CI: 28-32%); the proportion of children aged under 5 years sleeping under an ITN increased from <2% in 2000 to an estimated 68% (95% CI: 61–72%) in 2015. Despite progress made so far, high variability in the estimated proportion of the population sleeping under an ITN still exists among countries, with the median proportion being 74% among the fit countries with the highest estimates, and 20% among the fico countries with the lowest estimates [6]. A cross-sectional, community-based study carried out by Dawaki and colleagues in the North-Central region of Nigeria in 2013 documented a huge gap between ITN ownership and use; 79.5% had ITNs but only 49.5% used them [7]. This unsatisfactory compliance was similarly demonstrated in other studies in Nigeria [8,9] and other countries [10].

Efficacy trials to assess the health impact of ITNs were carried out in many countries in Africa, Asia, Latin America and the Western Pacific over a wide range of transmission intensities. These studies, mostly randomised-controlled trials, compared ITN use with non-usage and, less commonly, ITN use with use of untreated nets. The impacts measured included: all-cause child mortality (age 1–59 months), incidence of severe malaria, incidence of uncomplicated malaria episodes, prevalence of parasitaemia, mean haemoglobin level, splenomegaly, and nutritional status. Effectiveness trials were also conducted under programme conditions [11].

Studies done have shown that a relationship exists between ITN use and malaria parasitemia. Most of these have focused on the high-risk groups of pregnant women and under-five children. In a series of community-based surveys undertaken in 2007 in South-Central Somalia, an area of low-intensity malaria transmission, Noor and colleagues evaluated the parasitological impact of bed net use in 10,359 study subjects of all ages and they found a protective effectiveness of 39% (95% CI: 17–55, $P \leq 0.002$) in children under five years of age after adjusting for livelihood and gender [12]. A community-based cross-sectional survey done in Jos, Nigeria in 2007, to determine the prevalence of malaria parasitemia in under-fives in relation to ITN use, revealed a statistically significant relationship between ITN use and malaria parasitemia. Eleven out of 61 of subjects (7.3%) who slept under ITNs had malaria parasites in comparison with 46 out of 89 (30.7%) of those who did not [13]. The overall prevalence of malaria parasitemia in under-five children in that study was 38% (57 out of 150 subjects) [13]. The impact of ITNs on overall childhood mortality and malaria-related morbidity has been extensively evaluated. On the basis of five community-randomised trials, a Cochrane review concluded that, when full coverage is achieved, ITNs reduce all-cause child mortality by an average 18% in sub-Saharan Africa [14]. The general implication of this is that 5.5 lives could be saved per year for every 1000 children under 5 years of age protected. It was also concluded that ITNs reduce clinical episodes of malaria caused by *Plasmodium falciparum* and *P. vivax* infections by 50% on average, as well as reducing the prevalence of high-density parasitaemia [14].

Many of the cited studies on ITNs have been community-based and often interventional. These may not be truly representative of what obtains within the hospital setting. With regard to assessing the relationship between ITN usage and malaria parasitemia, as well as exploring factors affecting usage, little work has been done in a hospital setting within Abuja, hence, the reason for this study. This study was designed to find out if under-five children using ITN are less likely to have malaria parasitemia. It was hypothesised that use of ITN will protect against malaria. For the purpose of this study, malaria parasitemia was defined as the quantitative content of malaria parasites in the blood [15]. A child was a user of an ITN if he / she had slept under an ITN the night prior to being surveyed by the researcher. This is in keeping with the definition used by most researchers [16].

The study aim was to determine the relationship of ITN utilisation with malaria parasitemia in under-five children attending the General Paediatric Outpatient Department (GPOPD) in National Hospital Abuja (NHA), as well as, explore factors that affect use / non-use of ITNs, so as to give informed education on ITN use to parents / caregivers of children attending the clinics. Specific objectives were to determine the proportion of under-five children attending the GPOPD who sleep under ITNs; to identify the

knowledge, behavioural and socio-demographic factors among parents / caregivers which affect ITN utilisation by under-five children; and to compare the malaria parasite density among under-five children that use ITN and those that do not use ITN.

2. METHODOLOGY

2.1 Study Design

This was a descriptive, cross-sectional study.

2.2 Study Population and Sampling Strategy

The study population comprised children aged 6-59 months and their parents / caregivers that attended the GPOPD, NHA for management of illnesses and other services, between April and July 2014. Children less than 6 months were excluded from this study because within this age period, maternal antibodies within their blood are present in enough quantities to protect them from malaria and if included, may confound the effect of ITN use in this group of children.

Patients were selected using systematic sampling method. The GPOPD operated routinely, five days a week. Therefore, in order to have completed a sample size of 380 respondents within the three-month (thirteen-week) study period, an average of thirty respondents were recruited weekly, that is six respondents were recruited daily. The calculated sampling interval was approximately every 3rd patient.

On each clinic day, all the under-five patients were registered and using their allotted numbers, a paper ballot was done to randomly select the first under-five patient to be recruited. Thereafter, every third patient from that first selected under-five patient was recruited to participate in the study until the daily slot of six recruitees was completed. This was subject to written caregiver consent and those who did not consent received the usual care.

2.3 Data Collection

The pre-tested, validated, interviewer-administered questionnaire was applied. Two Family Medicine Resident Doctors were trained by the researcher as research assistants and they were able to make clarifications, where necessary, as well as receive support from the researcher throughout the course of the study. Data about caregivers' and children's socio-demographic characteristics, caregivers' knowledge about malaria and ITNs, preferred malaria control method, ownership of ITNs or lack thereof, problems encountered when using ITN, sleeping arrangements, type of house, and source of mosquito net, were collected. The questionnaire was structured into three sections namely socio-demographic characteristics, knowledge base, and intra-household dynamics.

Data on socio-demographic characteristics included gender of child and caregiver; age of child and caregiver; marital status of caregiver / respondent; educational level of the caregiver / respondent; occupation of respondent's partner; and the social class of the study participants [17]. The social class was determined using Olusanya's scoring system which considered a composite score of the caregiver's spouse / partner occupation and the level of educational attainment of the caregiver; the scores ranged from one to five (1 to 5) which corresponded with social classes 1 to 5 respectively [17].

Data on knowledge base explored caregiver knowledge of ITNs, the difference between ITNs and non-treated nets, cause of malaria, perception of effectiveness of ITNs in preventing malaria in under-fives. Respondents' perception of ITN effectiveness was graded in 'Likert scale manner' as 'very effective - 4, averagely effective - 3, less effective - 2, not effective at all – 1, and don't know - 0'. Those who considered ITN very effective and averagely effective (scores 4 and 3 respectively) were considered to have good perception, while those with lower scores were said to have poor perception.

Data on intra-household dynamics included housing structure, number of people in household, number of under-five children within household, sleeping arrangements, ITN ownership and use.

Additionally, while observing universal precautions, blood film smears were obtained by the researcher and two assistants via needle prick. These were prepared and stained with May Grunwald Giemsa stain (3% used) using Wintrobe's wedge slide technique [18]. Thick and thin films were prepared and analysed by a trained microscopist to document the presence or absence of malaria parasites and to quantify the parasitemia where present. Thin film was fixed with 100% methanol and slides were viewed at x100 objective. The parasite density was calculated by counting the number of

asexual parasites against a set number of white blood cells (WBCs), typically 200 or 300 in the thick blood film, and using a microlitre (µl), it was calculated by dividing the number of asexual parasites by the number of WBCs counted and then multiplying by an assumed WBC density (typically 8000 WBCs/µl) [19].

Serial numbers were allotted to every participant at the point of recruitment and these were used for identification of questionnaires and slides from the recruited patients. All patients who had malaria parasitemia were treated appropriately with artemisinin-based anti-malarial drug.

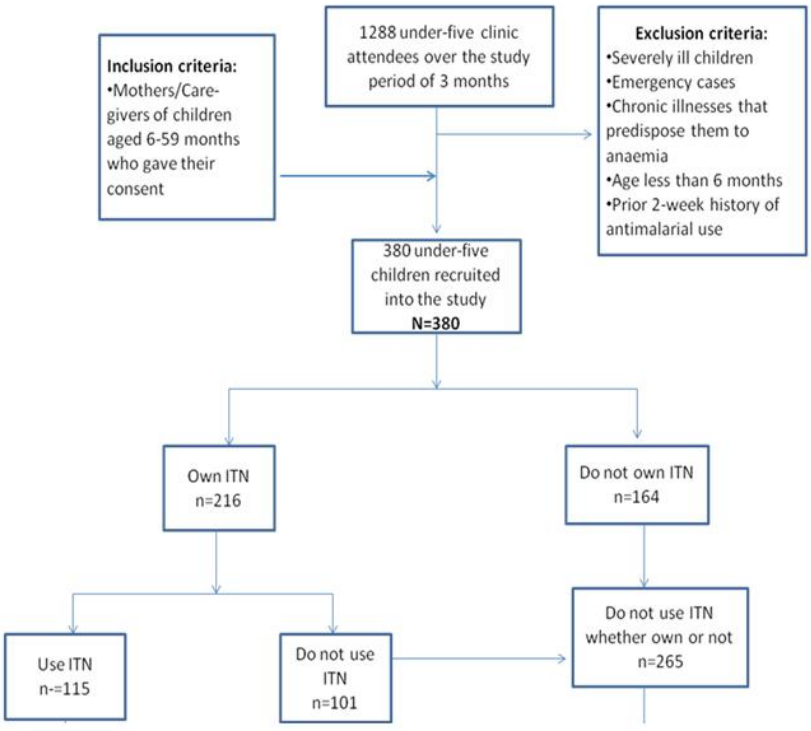
Data collection instrument: Pre-tested validated interviewer-administered questionnaire which made provision for entry of patient information on malaria parasite level.

2.4 Data Analysis

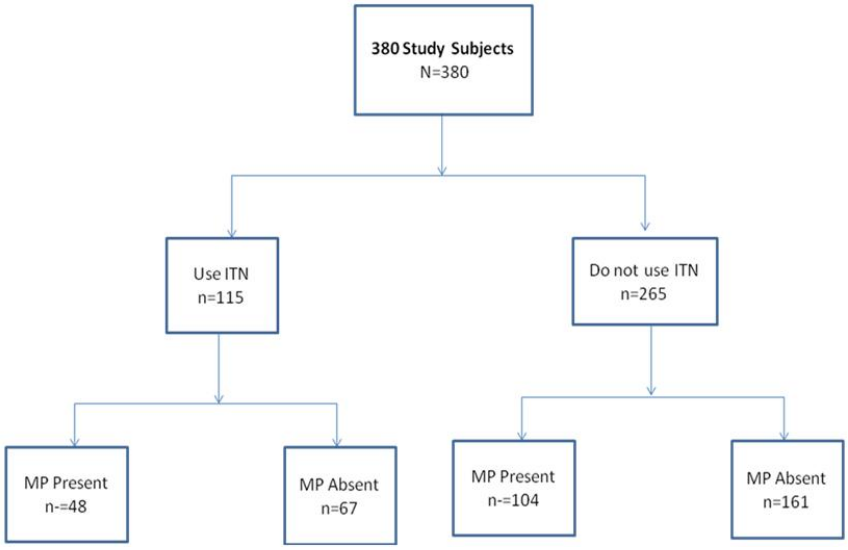
Data cleaning, sorting and coding, where appropriate, was done. Subsequent data entry was done by the researcher using Epi-info version 7 statistical software. (CDC Atlanta Georgia, 2012). Data analysis was done using the same software. Univariate and Bivariate analyses were carried out. Variables were summarised via descriptive statistics like frequencies, percentages, range, means and standard deviations. Frequency tables and pie charts were generated for relevant variables. Inferential statistics was done; Chi squared statistics was used to compare categorical variables, while Wilcoxon Rank Sum test was used for variables with skewed distribution. Confidence interval (CI) of 95% and p-value of $\leq$ 0.05 were considered significant. Logistic regression was to be used to remove effects of confounding factors and identify any association between ITN use, socio-demographic factors, and anaemia. In this study however, there was no need to conduct a logistic regression analysis because the tested association between study variables were not statistically significant.

3. RESULTS AND DISCUSSION

Altogether, 1288 under-five children were seen in the GPOPD during the study period. Of this number, 1150 met the inclusion criteria, out of which 380 were recruited for the study. There was no missing data and analysis was conducted on the data of all the study participants. The flow diagram is shown in Diagram 1 and 2.



Study flow Diagram 1



Study flow Diagram 2

3.1 Socio-Demographic Characteristics of the Subjects and Care-Givers

The mean age of the subjects was 26.5 months. The age range was from 6 to 59 months. Those in the age group 12 to 23 months were 108 (28.4%) and constituted the highest population of the subjects, while age groups 36 to 47 months and 48 to 59 months accounted for the lowest population at 55 each (14.5%). There were 200 female subjects (52.6%) and 180 males (47.4%).

The mean age of the care-givers was 33.8 years. The age range was from 17 years to 55 years. Those in the age group 31 to 40 years were 222 (58.4%) and constituted the highest population of the care-givers, while age extremes of $\leq$ 20 years and $\geq$ 50 years were 2 (0.5%). respectively and accounted for the lowest population. The female care-givers were 322 (84.7%) while the males were 58 (15.3%). Majority of the care-givers, 368 were married (96.8%) and most, 224 had tertiary/university education (59%). One hundred and eighty one (47.6%) of the care-givers' families were in social class 1.

The details of the socio-demographic characteristics of subjects and care-givers are outlined in Tables 1 and 2.

3.2 Proportion of ITN Owners and Users

The proportion of respondents who owned ITNs is shown in Fig. 1, while the proportion of under-five children who used ITN is shown in Fig. 2.

3.3 Other Descriptive Study Findings

ITN use was highest among the 12 to 23 months sub-group. Interestingly, non-use was also highest among them (see Fig. 3).

Table 1. Socio-demographic characteristics of subjects (under-fives)

Characteristics	Frequency, n (N = 380)	Percentage (%)
Gender		
Male	180	47.4
Female	200	52.6
Age group (months)		
<12	75	19.7
12-23	108	28.4
24-35	87	22.9
36-47	55	14.5
48-59	55	14.5
Birth order		
1st	156	41.1
2nd	106	27.9
3rd	68	17.9
4th and above	50	13.1

The distribution of malaria parasitemia according to age group is shown below. Highest prevalence was recorded amongst the younger age groups.

3.4 Knowledge Related to ITNs, Malaria and Anaemia

Of the 380 respondents, 354 (93.2%) knew what ITNs are. An equally high proportion, 368 (96.8%) knew that malaria was caused by mosquito bite. Nine (9) respondents mentioned stress as a

cause of malaria, three said dirty environment and two said cold was a cause. Only 232 (61%) of the respondents knew malaria could cause anaemia.

Table 2. Socio-demographic characteristics of care-givers

Characteristics	Frequency, n (N = 380)	Percentage (%)
Gender		
Male	58	15.3
Female	322	84.7
Age group (years)		
≤20	2	0.5
21-30	112	29.5
31-40	222	58.4
41-50	42	11.1
>50	2	0.5
Marital status		
Single	8	2.1
Married	368	96.8
Divorced	1	0.3
Widowed	3	0.8
Highest level of formal education		
Primary/no formal education	13	3.4
Secondary/Tertiary not University	143	37.6
University	224	59.0
Occupation		
Professionals, civil servants, politicians, business people	183	48.2
Middle-level bureaucrats, technicians, skilled artisans, traders	101	26.6
Unskilled, unemployed or below minimum wage-earners	96	25.2
Occupation of care-givers' partners		
Professionals, civil servants, politicians, business people	245	64.5
Middle-level bureaucrats, technicians, skilled artisans, traders	111	29.2
Unskilled, unemployed or below minimum wage-earners	24	6.3
Social class by Olusanya		
1 (Upper socio-economic class)	181	47.6
2 (Upper socio-economic class)	99	26.1
3 (Middle socio-economic class)	78	20.5
4 (Lower socio-economic class)	15	4.0
5 (Lower socio-economic class)	7	1.8

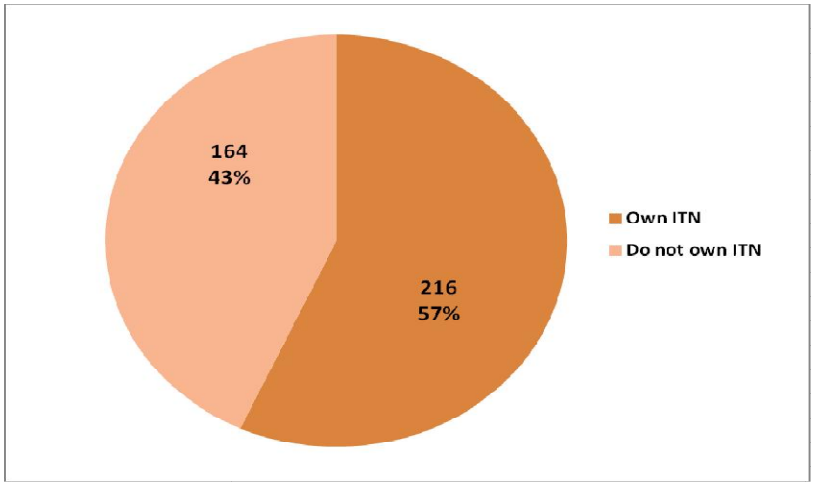


Fig. 1. Proportion of participants that own ITNs

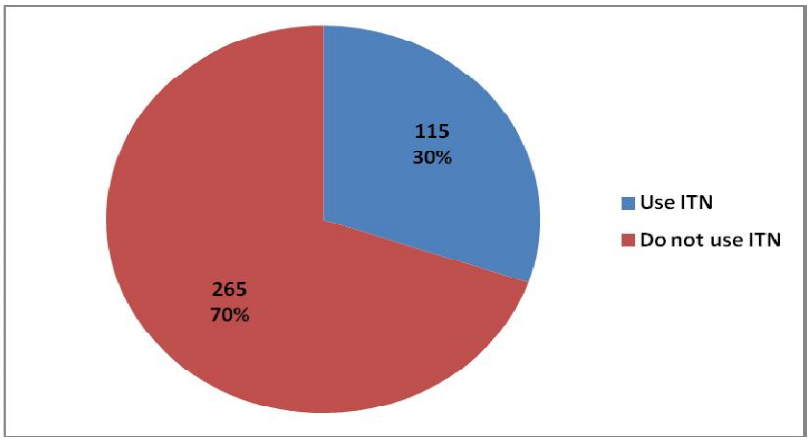


Fig. 2. Proportion of participants that use ITNs (slept under net the night prior to study)

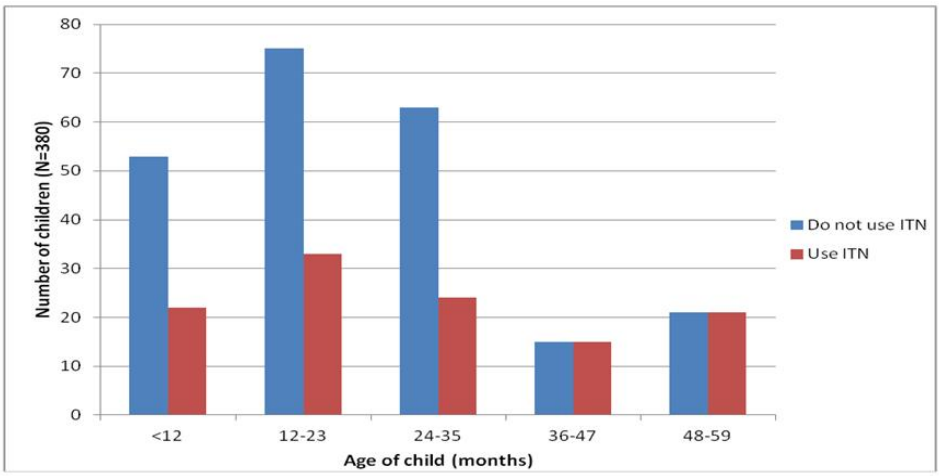


Fig. 3. ITN use / non-use according to age group (under-fives)

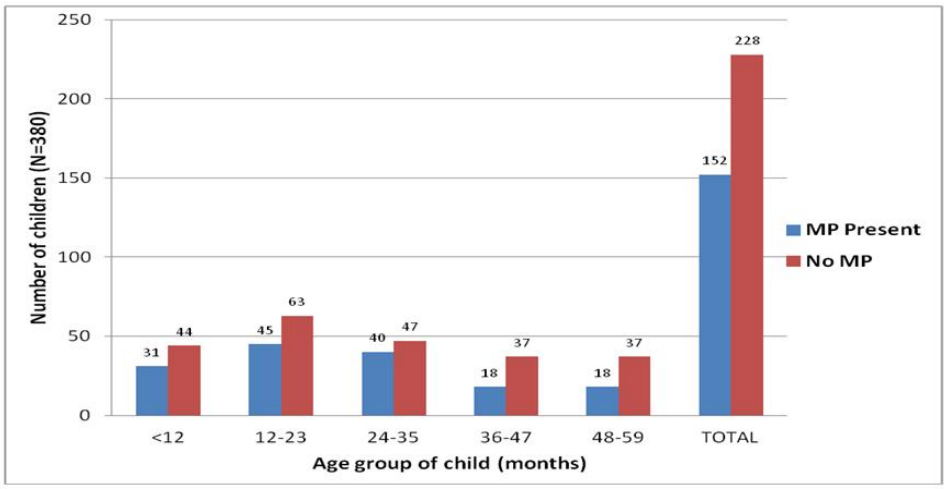


Fig. 4. Malaria parasitemia distribution according to age group of participants

Table 3. Respondents' knowledge of ITN, malaria and malaria-related anaemia

Question domain	Frequency (N=380)	Percentage (%)	95% CI
Know what ITN is			
Yes	354	93.2	90.01 – 95.40
No	26	6.8	4.60 – 9.99
Cause of malaria*			
Mosquito bite	368	96.8	94.40 – 98.28
Stress	9	2.4	
Dirty environment	3	0.8	
Cold	2	0.5	
Know that malaria can cause anaemia			
Yes	232	61.1	55.93 – 65.95
No	63	16.5	13.06 – 20.79
Don't know	85	22.4	18.35 – 26.96

**A few respondents gave multiple answers, maximum of two*

Table 4. Respondents' practice / behaviour regarding sleeping arrangement and ITN use

Behaviour	Frequency, n (N=380)	Percentage (%)
Sleeping arrangement		
Child sleeps alone	52	13.7
Child sleeps with parents	302	79.5
Child sleeps with others (siblings, nanny, etc)	26	6.8
All household members sleep on bed		
Yes	288	75.8
No	92	24.2
Frequency of ITN use		
Everyday	115	30.3
1 - 2 times a week	21	5.5
≥ 3 times a week	14	3.7
Non-use	66	17.3
Do not own ITN	164	43.2

3.5 Behaviour

Three hundred and two under-fives (79.5%) slept in their parents' bed. Two hundred and eighty eight (75.8%) respondents said all their household members slept on beds.

One hundred and fifteen out of the three hundred and eighty (30.3%) respondents said that subjects used ITN everyday, 21 (5.5%) said they used ITN 1-2 times a week, 14 (3.7%) said ≥3 times a week and 66 (17.3%) said they did not use ITN despite ownership. One hundred and sixty four, 164 (43.2%) of the respondents did not own ITN.

3.5.1 Reasons for non-use of ITNs

Various reasons were given by the respondents as shown in Table 5.

Ninety-eight respondents gave specific reasons for non-use of ITNs; this represented less than 50% of non-users of ITN. The most commonly given reason for non-use was heat. Many also complained of the problem of hanging.

Table 5. Reasons given by respondents for non-use of ITNs

*Reasons given	Number of respondents (n=265)
No mosquitoes around	10
Problem of hanging	33
Heat	41
Suffocation	3
Fear of irritation from the ITN	8
Indoor residual spraying done	3
No reason given for non-use or don't have ITN	167

**Some respondents gave no reason at all for non-use. It seemed it was just their personal preference*

3.6 Perception of ITN Effectiveness

About two-thirds of the respondents, 252 (66.3%) opined that ITNs were very effective in preventing malaria in children under-five. Less than 1% of respondents, 2 (0.5%) thought ITNs were not effective at all.

3.7 Relationship between ITN Use and Other Study Variables (Socio-Demographics, Knowledge)

3.7.1 ITN use and child demographics

Bivariate analysis of socio-demographic factors – gender of child, age group of child, and birth order, revealed there was no statistically significant difference between ITN users and non-users.

Table 6. Respondents perception of ITN effectiveness

Perception of ITN	(N=380) Frequency (n)	Percentage	95%, CI
Very effective	252	66.3	61.29 – 71.01%
Averagely effective	87	22.9	18.83 – 27.52%
Less effective	8	2.1	0.98 – 4.27%
Not effective at all	2	0.5	0.09 – 2.10%
Don't know	31	8.2	5.70 – 11.50%

Table 7. Relationship between ITN use and child demographics

	ITN use		Test stat.	*P* value
	No	Yes		
Total	265	115		
Gender: Child			$\chi 2 = 1.0$	0.10
Female	140 (52.8)	60 (52.2)		
Male	125 (47.2)	55 (47.8)		
Age: Child			$\chi 2 = 2.2$	0.70
<12	53 (20)	22 (19.1)		
12-23	75 (28.3)	33 (28.7)		
24-35	63 (23.8)	24 (20.9)		
36-47	40 (15.1)	15 (13)		
48-59	34 (12.8)	21 (18.3)		
Birth order			$\chi 2 = 2.1$	0.54
1st child	109 (41.1)	47 (40.9)		
2nd child	71 (26.8)	35 (30.4)		
3rd child	46 (17.4)	22 (19.1)		
4th child and above	39 (14.7)	11 (9.6)		

Table 8. Relationship between ITN use and care-giver demographics

	ITN use		Test stat.	*P* value
	No	Yes		
Total	265	115		
Gender: care-giver			$\chi^2 = 2.36$	0.12
Female	230 (71.4)	92 (28.6)		
Male	35 (60.3)	23 (39.7)		
Age: care-giver			Extended Mantel-Hantzel	0.90
20 years or less	2 (0.8)	0 (0)	=0.001	
21-30 years	78 (29.4)	34 (29.6)		
31-40 years	155 (58.4)	67 (58.2)		
41-50 years	28 (10.6)	14 (12.2)		
50 years or more	2 (0.8)	0 (0)		
Highest education: Care-giver			$\chi^2 = 3.5$	0.17
Primary/no formal education	10 (3.8)	3 (2.6)		
Secondary/Tertiary not University	107 (40.4)	36 (31.3)		
University	148 (55.8)	76 (66.1)		
Social class			Extended Mantel-Hantzel	0.15
1	121 (45.7)	60 (52.3)	=2.05	
2	71 (26.8)	28 (24.3)		
3	56 (21.1)	22 (19.1)		
4	10 (3.8)	5 (4.3)		
5	7 (2.6)	0 (0)		
Perception of ITN effectiveness			$\chi^2 = 3.12$	0.08
Good	231 (87.2)	108 (93.9)		
Poor	34 (12.8)	7 (6.1)		

	ITN use		Test stat.	*P* value
	No	**Yes**		
Housing structure			χ^2 = 1.71	0.79
Self-contained	6 (2.3)	3 (2.6)		
One bedroom	64 (24.2)	24 (20.9)		
Two bedrooms	113 (42.6)	57 (49.6)		
Three bedrooms	60 (22.6)	23 (20.0)		
More than 3 bedrooms	22 (8.3)	8 (6.9)		

Table 9. Relationship between ITN Use and the knowledge that mosquito bite can transmit malaria

	ITN use		Total	Test stat.	*P* value
	No	**Yes**			
Total	265	115	380		
Knowledge that mosquito bite can transmit malaria				χ^2 = 3.35	0.07
No (n=12)	5 (41.7)	7 (58.3)	12		
Yes (n=368)	260 (70.7)	108 (29.3)	368		

Table 10. Malaria parasite density of ITN users and non-users

	ITN use*		Test stat.	*P* value
	No	**Yes**		
Total*	104	48		
Parasite density*				
Log mean PD	2.14 ± 0.46	2.12 ± 0.53	T test	0.09
Median (Inter-quartile range, IQR)	120 (100, 220)	120 (100, 180)		

**In those with positive MPs*

3.7.2 ITN use and care-giver demographics

Bivariate analysis of care-giver age, gender, highest educational qualification, social class, housing structure, and perception of ITN effectiveness showed no statistically significant association with ITN use.

3.7.3 Relationship between ITN use and the knowledge that mosquito bite can transmit malaria

Of the 368 respondents that knew that mosquito bite can transmit malaria, 108 (29.3%) used ITN while 260 (70.7%) did not. Twelve respondents did not know that mosquito bite could transmit malaria. There was no statistically significant relationship between this knowledge and ITN use.

3.8 Malaria Parasite Density

*The overall log mean parasite density was 2.14 ± 0.48 (SD).

The parasite density was not normally distributed but the median was the same (120) in both those who use ITN and those who do not. The log mean parasite density for non-users of ITN was similar to that of ITN users. There was no statistically significant relationship between parasite density and ITN use.

There was also no statistically significant relationship between malaria parasitemia and ITN use, *P* value 0.73.

This hospital-based, cross-sectional study was carried out to ascertain the relationship between utilisation of insecticide-treated nets (ITNs) and malaria parasitemia in under-five children attending the GPOPD of the National Hospital Abuja. Many small-scale and large-scale studies, done in this regard have shown varying outcomes, though mostly positive [20,21,22-25].

This study focused on under-five children and the mean age of the 380 subjects studied was 26.5 ± 15.3 months. This compares well with a community-based, comparative, interventional study on 'Malaria and the Use of the Insecticide-Treated Net (ITN) among Under-Five Children' carried out by Ashikeni et al. [26] in Abuja,

Table 11. Comparison of malaria Parasitemia in ITN users and non-users

Variable	ITN users n=115	ITN non-users n=265	Total (%)	95% CI	Chi-square, χ^2	*P* value
Malaria parasitemia					**0.1**	**0.73**
Absent	67	161	228 (60.0)	54.9 – 64.9		
Present	48	104	152 (40.0)	35.1 – 45.1		

Nigeria in 2013, where the mean age of under-fives studied was 26.7 ± 15 months in the control group and slightly lower in the intervention group, 18.4 ± 12 months. This similarity may have been because, this researcher's study, though hospital-based, was carried out in Abuja as well, thus similar socio-demographics were likely. Another hospital-based study in North-Western Nigeria by Umaru et al. in 2015 which sought to ascertain the prevalence of malaria in 1173 patients, of which 414 (35.3%) were under-five children had their mean age as 27 ± 13 months, similar to this study finding. Umaru's study was carried out in the same Northern region of Nigeria as this study.

3.9 Reported ITN Ownership and Utilisation (Under-five ITN Utilisation)

This researcher's study reported that 57% (216 of 380) of the respondents owned ITNs within their household and this is way below the World Health Assembly target of 80%. This finding is similar to that by Astatkie and associates in a community-based cross-sectional survey of 454 Ethiopian households in 2007 where ITN ownership was 58.8% (267 of 454) and utilisation by under-fives was 40.3% [27]. The rate of ITN utilisation in this study was however lower 30% (115 of 380), than that of Astatkie's study. This may have been due to the fact that the recall period for ITN usage in this researcher's study was the night prior to survey while that of Astatkie was over the preceding 12 months. Though recall bias is a limitation in both studies, the longer recall period in Astatkie's study puts it at a greater risk of recall / information bias than this researcher's study. Also, there was selection bias in Astatkie's study as the selection of respondents started from households situated in the centres of the selected kebeles (sub-towns) with possible exclusion of respondents in the peripheral parts of the kebeles. Additionally, the sampling technique used was proximity sampling which could have resulted in clustering of respondents with similar characteristics. It is interesting to note that ITN ownership was similar in both studies, despite the difference in malaria epidemiology in both malaria-endemic regions; malaria transmission was seasonal and unstable in Ethiopia while it was stable in this researcher's region [27]. Earlier studies documented even much lower findings. In a systematic cluster sample survey of 1080 households in Malawi in 2000 by Holtz et al. [28] ITN ownership was 20.5% of the 672 households that had under-five children, while utilisation was 3.3% of rural children and 24.0% of urban children under five. Interestingly, these low figures were recorded after fifteen months of socially marketed bednet sales. Pervasive poverty and the expense of the nets were the main reasons given for the lack of nets in households in Holtz's study. Similarly low figures were noted in a review of 13 surveys in SSA countries between 1991 and 2001 by Korenromp et al. [29] in which ITN possession ranged from 0.1% to 28.5% and utilisation by under-fives ranged from 0% to 16%. Seasonal variation in net use was considered to be a reason for their findings. They noted that the discrepancy between ITN possession and use was remarkably consistent across countries and sub-regions and they opined that it may have been indicative of inadequate promotion of /advocacy for consistent net use all year round. It is possible that this may be a contributory factor to this researcher's finding as well.

A more recent community-based, cross-sectional survey of 784 households in Ethiopia by Teklemariam and associates reported 57.9% ownership of ITNs, with 73.3% of the ITN-owning households using them. They however noted that only 57.9% of ITN owners demonstrated proper use [30]. Level of ownership of ITN was much higher in Teklemariam's study than the finding of 21.5% reported in Biadglilign's study which was also done in Ethiopia [31]. Despite the fact that about 75% of Ethiopia's landmass is malaria-endemic, coverage and proper utilisation were noted to be limited due to lack of sustainable distribution and issues related to replacement of nets, seasonality of malaria, and poor knowledge of the community with regard to the link between mosquitoes and malaria. Though some of these above-listed issues may be challenges also in this researcher's locality, the fact that use was low despite good knowledge of respondents

suggests that other factors may be at work here. A cross-sectional, comparative survey of 2373 households conducted during peak malaria transmission in Ethiopia in 2013 reported 56.6% ITN ownership, similar to this study. They observed that being poor, distant from health services and inaccessible to vehicle transport rendered some disadvantaged in terms of ITN possession [32].

On the other hand, Githinji et al. [33] in a survey of 670 households in Kenya in 2006 reported 95% ITN ownership and under-five utilisation of 59%, both much higher than this study's findings. This very high level of ownership was probably due to mass distribution campaigns which proved to be a more effective and equitable means of increasing coverage than highly subsidised clinic nets programme and commercial social marketing [34]. A cross-sectional study of eight health centres in Kenya by Osero et al. [35] reported lower under-five utilisation rate of 23.8%. Eyobo et al. [36] in the 2009 MIS for South Sudan, found that household ITN ownership was 49.7% (95% CI: 48.2-51.2) and utilisation was low; 25.3% (95% CI: 23.9-26.7) for children under five (U5) and prevalence of infection was 24.5% (95% CI: 23.0-26.1) in children under five years. These were lower than the findings in this study. The researcher is of the opinion that the protracted conflict situation in South Sudan may have been the reason for this [36].

ITN ownership and use has remained low and inequitable among different socio-economic groups in many parts of sub-Saharan Africa despite the variety of strategies that have been used to boost ITN coverage across SSA [37]. These strategies include the promotion of the commercial market [38], commercial sector enhancement through promotions and subsidies (social marketing) [39,40] and the provision of free ITNs to vulnerable groups through community distributions or primary care clinics [41-43].

Various reasons have been cited in studies for non-use of ITNs despite ownership. In this study, the most commonly cited reason was heat, followed by the problem of hanging. Other reasons given were: perception of no mosquitoes around, fear of irritation from ITN, suffocation and indoor residual spraying done. Kimbi and associates in a cross-sectional study in Cameroon reported 47% ITN ownership while utilisation by under-fives was 38% [44]. The low utilisation of ITNs by under-fives (38%) was however, higher than the 13% reported for 2006 in Cameroon before the free distribution of ITNs/LLINs to households with under-fives in the health district. They attributed the relatively low utilisation and resultant gap between ownership and use largely to socio-demographic and personal factors and not due to lack of ITNs. Some ITNs were found still sealed inside their packages, while some were hung on windows [44]. This phenomenon is common in many sub-Saharan countries. Perhaps, with the low level of education, in some cases the respondents did not appreciate why they should use nets or how to hang them up [45,46]. Tsuang et al. [47] postulated that many household members may have been forced to make difficult decisions about who should sleep without the protection of the ITN, implying that intra-household saturation was still low. Diabate has argued, and maybe rightly so that, intra-household saturation with ITNs, though an imperfect indicator, is a more informative indicator of access than the commonly used measure of possession of at least one ITN per household which does not take into account household size or sleeping places and consequently does not precisely indicate the extent to which individuals have real access to the nets. He stated that "the gap between ownership rates per household and intra-household saturation with ITNs is so large that monitoring access to bed nets based on the former could be misleading. Similarly, the proportion of households with at least one ITN hanging or in very good physical condition also overestimates individuals' access to bed nets and, ultimately, population levels of protection". He concluded that because ITN access multiple factors beyond household ownership, an accurate understanding of access to bed nets and the assessment of campaign outcomes should be based on appropriate measurements of these three components [48].

3.10 Factors affecting ITN Utilisation (Knowledge, Behavioural and Socio-demographic)

Numerous factors ranging from socio-demographic to behavioural, economic and cultural affect ITN utilisation but findings on the statistical significance of these factors have been variable. This study did not reveal any statistically significant association between ITN use and socio-demographic characteristics of child (age, gender, birth order) and care-giver (age, gender, highest educational qualification, social class, housing structure), as well as their

perception of ITN effectiveness. In many studies involving several age groups, the finding has been that ITN use was highest among under-fives. In a study by Malusha and co-workers, a little more than half of treated nets were used by under-fives (52.2%) compared to 47.8% used by children over five years including adults. The main reason cited by majority of care-givers as a hindrance to net utilisation was lack of treated nets in households (72.3%). Utilisation of ITNs by under five children was found to be positively associated with knowledge of ITNs (p = 0.024), marital status (p = 0.018) and occupation (p = 0.043) [49]. This is contrary to the findings in the study where there was no significant association between knowledge of malaria and ITN utilisation.

3.11 Strengths of the Study

There was a 100% response rate in the study. Also, the risk of recall bias was minimised because the definition of ITN usage was limited to the night prior to the survey.

4. LIMITATIONS OF THE STUDY

The cross-sectional design of this study makes it difficult to draw any valid conclusions about any association or possible causality. Additionally, net usage in this study was reported and the researcher was unable to verify respondents' claims. This makes the study subject to reporting bias, social desirability and ultimately misclassification bias.

Also, a comparative study design of malaria parasitemia between ITN users and non-users would have enriched the study. However, a longitudinal study would be a more appropriate study. Surveys may need to cover periods sufficiently long enough to detect trends and quantify the effects of interventions. Furthermore, a community-based survey may have yielded a more accurate representation of the situation of ITN use and malaria parasitemia in under-fives.

5. RECOMMENDATIONS

In view of the study findings, the researcher suggests the following:

1. More studies (with appropriate designs and possibly, greater power than used in this study) should be done to investigate further, the factors that are responsible for the gap between ITN ownership and usage.
2. There is need to invest more in behaviour change interventions that are designed to bridge the identified gap.
3. Health education on proper ITN usage should be provided in all health facilities. Broadening the context of usage beyond high-risk groups may help to make 'universal coverage' a reality.

6. CONCLUSION

The study clearly revealed that the gap between ITN ownership and utilisation, as reported in other studies is still quite prevalent in this environment. ITN ownership level in this study was 57%, while reported ITN usage was 30%. The study did not demonstrate any significant association between ITN use and malaria parasitemia.

CONSENT

All authors declare that written informed consent was obtained from the patient for publication of this research article.

ETHICAL CONSIDERATIONS

Ethical approval (reference number NHA/EC/211/2013), dated 5th April, 2013, was given by the Research and Ethics Committee of National Hospital Abuja. Written informed consent was obtained from all recruited patients.

ACKNOWLEDGEMENTS

Hearty thanks to Dr. Adamu Onu and Dr. Bimbo Silva for their insightful critique and hard questions which helped loosen some of the knotty points.

I appreciate each of the Parents of my study subjects, who allowed me take blood samples from their precious babies and also took time to provide responses to my Questionnaire for this work.

I thank Dr. S. Gidado, for his skill, industry and patience in turning my data to workable statistics. I am grateful to the Medical Microbiology Lab. Scientist – Mr. Tiri; Haematology Lab. Scientists, especially Mr. Tunde Afolayan for their contribution to my laboratory analysis, all of whom painstakingly analysed over 380 (three hundred and eighty) samples I sent to them for this work.

The first author received partial financial sponsorship from her Residency Training Institution.

I thank my colleagues - Residents in the Department of Family Medicine, NHA for their support, encouragement, and constructive criticism during the period of this work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Malaria Report 2016. WHO Press, Geneva, Switzerland; 2016.
2. Roll Back Malaria. Global Malaria Action Plan for a malaria-free world; 2008. Available:http://www.rollbackmalaria.org/gmap/toc.html
[Accessed on 12 September, 2015]
3. World Malaria Report 2010. WHO Press, Geneva, Switzerland; 2010.
4. National Population Commission (NPC) [Nigeria], National Malaria Control Programme (NMCP) [Nigeria], and ICF International. Nigeria Malaria Indicator Survey 2015. Abuja, Nigeria: NPC, NMCP, and ICF International; 2012.
5. World Health Organization. Policies, strategies and targets for malaria control. Geneva, Switzerland: WHO World Malaria Report; 2008.
6. World Malaria Report 2015. WHO Press, Geneva, Switzerland; 2015.
7. Dawaki S, Al-Mekhlafi HM, Ithoi I, Ibrahim J, Atroosh WM, Abdulsalam AM, et al. Is Nigeria winning the battle against malaria? Prevalence, risk factors and KAP assessment among Hausa communities in Kano State. Malaria Journal. 2016; 15(1):351.
8. Noland GS, Graves PM, Sallau A, Eigege A, Emukah E, Patterson AE, et al. Malaria prevalence, anemia and baseline intervention coverage prior to mass net distributions in Abia and Plateau States, Nigeria. BMC Infectious Diseases. 2014; 14(1):168.
9. Kilian A, Koenker H, Baba E, Onyefunafoa EO, Selby RA, Lokko K, et al. Universal coverage with insecticide-treated nets–applying the revised indicators for ownership and use to the Nigeria 2010 malaria indicator survey data. Malaria Journal. 2013;12(1):314.
10. Atieli HE, Zhou G, Afrane Y, Lee MC, Mwanzo I, Githeko AK, et al. Insecticide-treated net (ITN) ownership, usage, and malaria transmission in the highlands of western Kenya. Parasite Vectors. 2011; 4:113.
11. Insecticide-treated mosquito net interventions: A manual for national control programme managers / edited by roll back malaria. Publication by World Health Organisation, Geneva; 2003.
Available:http://apps.who.int/iris/bitstream/10665/42685/1/9241590459_eng.pdf
(Last accessed on 10th December, 2015)
12. Noor AM, Moloney G, Borle M, Fegan GW, Shewchuk T, Snow RW. The use of mosquito nets and the prevalence of *Plasmodium falciparum* infection in Rural South Central Somalia. PLoS ONE. 2008; 3(5):e2081.
13. Daboer JC, MP, Chingle MP, Ogbonna C. Malaria parasitemia and household use of insecticide treated bed nets: A cross-sectional survey of under-fives in Jos, Nigeria. Niger Med J. 2010;51(1):5-9.
14. Lengeler C. Insecticide-treated bednets and curtains for preventing malaria. Cochrane Database of Systematic Reviews. 2000;2:CD000363.
(update Cochrane Database of Systematic Reviews. 2004;2:CD000363.
15. Worldwide prevalence of anaemia report 1993-2005. WHO global database on anaemia. Publication by World Health Organisation, Geneva; 2008.
Available:http://www.who.int/vmnis/anaemia/prevalence/en/
(Last accessed on 12 February, 2013)
16. Yunis MA, Amare D, Wodwoson K. Does insecticide treated mosquito nets (ITNs) prevent clinical malaria in children aged between 6 and 59 months under program setting? J Community Health. 2009;34: 102-112.
17. Olusanya O, Okpere E, Ezimokhai M. The importance of social class in fertility control in a developing country. West African Journal of Medicine. 1985;4:4.
18. Houwen B. Blood film preparation and staining procedures. Laboratory Hematology. 2000;6:1–7.
Available:http://mmserver.cjp.com/gems/blood/LH.6.1.Houwen.pdf
(Last accessed on 5 February, 2013)

19. Assessment and monitoring of antimalarial drug efficacy for the treatment of uncomplicated falciparum malaria. Publication by World Health Organisation. Available:http://www.who.int/malaria/publications/atoz/.../en/
(Last accessed on 16 November, 2012)
20. Binka FN, Kubaje A, Adjuik M, Williams LA, Lengeler C, Maude GH, et al. Impact of permethrin impregnated bednets on child mortality in Kassena-Nankana district, Ghana: a randomized controlled trial. Trop Med Int Health. 1996;1:147–154.
21. Nevill CG, Some ES, Mung'ala VO, Mutemi W, New L, Marsh K, et al. Insecticide-treated bednets reduce mortality and severe morbidity from malaria among children on the Kenyan coast. Trop Med Int Health. 1996;1:139–146.
22. Alonso PL, Lindsay SW, Armstrong Shellenberg JRM, Keita K, Gomez P, Shenton FC, et al. A malaria control trial using insecticide-treated bed nets and targeted chemoprophylaxis in a rural area of The Gambia, West Africa: 6. The impact of the interventions on mortality and morbidity from malaria. Trans R Soc Trop Med Hyg. 1993;87:37-44.
23. D'Alessandro U, Olaleye B, McGuire W, Langerock P, Bennett S, Aikins M, et al. Mortality and morbidity from malaria in Gambian children after introduction of an impregnated bednet programme. Lancet. 1995;346:462-467.
24. Huailu C, Wen Y, Wuanmin K, Chongyi L. Large-scale spraying of bednets to control mosquito vectors and malaria in Sichuan, China. Bull World Health Organ. 1995;73:321-328.
25. Hawley WA, ter Kuile FO, Steketee RS, Nahlen BL, Terlouw DJ, Gimnig JE, et al. Implications of the western Kenya permethrin-treated bed net study for policy, program implementation, and future research. Am J Trop Med Hyg. 2003;(Suppl 4):168-173.
26. Ashikeni MA, Envuladu EA, Zoakah AI. Malaria and the use of the insecticide-treated net (ITN) among under-five children in Kuje Area Council of the Federal Capital Teritory Abuja, Nigeria. Journal of Mosquito Research. 2013; 3(6):45-53.
27. Astatkie A, Feleke A. Utilisation of insecticide treated nets in Arbaminch Town and the malarious villages of Arbaminch Zuria District, Southern Ethiopia. Ethiop. J. Health Dev. 2010;24:15-24.
28. Holtz TH, Marum LH, Mkandala C, Chizani N, Roberts JM, Macheso A, et al. Insecticide-treated bednet use, anaemia, and malaria parasitemia in Blantyre District, Malawi. Trop Med Int Health J. 2002;7: 220-230.
29. Korenromp EL, Miller J, Cibulskis RE, Cham MK, Alnwick D, Dye C. Monitoring mosquito net coverage for malaria control in Africa: possession vs. use by children under 5 years. Tropical Medicine and International Health. 2003;8(8):693–703.
30. Teklemariam Z, Awoke A, Dessie Y, Weldegebreal F. Ownership and utilization of insecticide-treated nets (ITNs) for malaria control in Harari National Regional State, Eastern Ethiopia. The Pan African Medical Journal. 2015;21:52.
31. Biadgilign S, Reda A, Kedir H. Determinants of ownership and utilisation of insecticide-treated bed nets for malaria control in Eastern Ethiopia. Journal of Tropical Medicine. 2012;Article ID 235015: 7.
32. Sena LD, Deressa WA, Ali AA. Predictors of long-lasting insecticide-treated bed net ownership and utilization: Evidence from community-based cross-sectional comparative study, South-west Ethiopia. Malar J. 2013;12: 406.
33. Githinji S, Herbst S, Kistemann T, Noor AM. Mosquito nets in a rural area of Western Kenya: Ownership, use and quality. Malaria Journal. 2010;9:250.
34. Van-den-Ende J, et al. Recurrence of blackwater fever: Triggering of relapses by different antimalarials. Trop. Med. Int. Health 1998;3:632–639. In: Menendez C, Fleming AF, Alonso PL. Malaria-related Anaemia. Parasitology Today. 2000;16(11): 469-476.
35. Osero JS, Oteino MF, Oraqo AS. Maternal use of insecticide-treated nets in the prevention of malaria among children under five years in Nyamira district, Kenya. East Afr. Med. J. 2005;82:495-500.
36. Eyobo MB, Awur AC, Wani G, Julla AI, Constantino DR, Sebit B, et al. Malaria Indicator Survey 2009, South Sudan: baseline results at household level. Malaria Journal. 2014;13:45.
37. Noor A, Mutheu JJ, Tatem AJ, Hay SI, Snow RW. Insecticide-treated net coverage in Africa: mapping progress in 2000-07. Lancet. 2009;373:58-67.

38. NETMARK: Public-private partnership for sustainable malaria prevention; 2004. Available:http://www.netmarkafrica.org/ITNs/
39. Schellenberg JR, Abdulla S, Minja H, Nathan R, Mukasa O, Marchant T, Mponda H, Kikumbih N, Lyimo E, Manchester T, Tanner M, Lengeler C. KINET: A social marketing programme of treated nets and net treatment for malaria control in Tanzania, with evaluation of child health and long-term survival. Trans R Soc Trop Med Hyg. 1999;93:225-231.
40. Mushi AK, Schellenberg JR, Mponda H, Lengeler C. Targeted subsidy for malaria control with treated nets using a discount voucher system in Tanzania. Health Policy Plan. 2003;18:163-171.
41. Grabowsky M, Nobiya T, Ahun M, Donna R, Lengor M, Zimmerman D, et al. Distributing insecticide-treated bednets during measles vaccination: A low-cost means of achieving high and equitable coverage. Bull World Health Organ. 2005; 83:195-201.
42. Grabowsky M, Nobiya T, Selanikio J: Sustained high coverage of insecticide-treated bednets through combined Catch-up and Keep-up strategies. Trop Med Int Health. 2007;12:815-822.
43. Guyatt HL, Gotink MH, Ochola SA, Snow RW. Free bednets to pregnant women through antenatal clinics in Kenya: A cheap, simple and equitable approach to delivery. Trop Med Int Health. 2002;7:409-420.
44. Kimbi HK, Nkesa SB, Ndamukong-Nyanga JL, Sumbele IUN, Atashili J, Atanga MBS. Socio-demographic factors influencing the ownership and utilization of insecticide-treated bed nets among malaria vulnerable groups in the Buea Health District, Cameroon. BMC Research Notes. 2014; 7:624.
45. Afolabi BM, Sofola OT, Fatunmbi BS, Komakech W, Okoh F, Saliu O, et al. Household possession, use and non-use of treated or untreated mosquito nets in two ecologically diverse regions of Nigeria-Niger Delta and Sahel Savannah. Malar J. 2009;8(308):10-1186.
46. Monasch R, Reinisch A, Steketee RW, Korenromp EL, Alnwick D, Bergevin Y. Child coverage with mosquito nets and malaria treatment from population based surveys in African countries: A baseline for monitoring progress in RBM. Am J Trop Med Hyg. 2004;71:232–238.
47. Tsuang A, Lines J, Hanson K. Which family members use the best nets? An analysis of the condition of mosquito nets and their distribution within households in Tanzania. Malar J. 2010;9:211.
48. Diabate S, Druetz T, Bonnet E, Kouanda S, Ridde V, Haddad S. Insecticide-treated nets ownership and utilisation among under-five children following the 2010 mass distribution in Burkina Faso. Malaria Journal. 2014;13:353.
49. Malusha JM, Mwanzo I, Yitambe A, Mbugi JP. Use of insecticide treated nets among caregivers of children under five years in Makueni District, Kenya. East Afr Med J. 2009;86:308-313.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/19408