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Caregivers' Vector Control Methods and its Effect on Malaria Infection in Febrile Children Presenting in a Tertiary Hospital in Nigeria

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Abstract: : *Background:* Malaria is a major public health problem in sub-Saharan Africa. Several efforts are being made to reduce its prevalence and morbidity in Nigerian children with emphasis on vector control measures.
Methods: This was acrosssectional descriptive study conducted on 382 febrile children seen at a tertiary hospital in Nigeria over an eight-month period. A structured questionnaire was used to collect information on sociodemographic, vector control measures and care given to the subjects. Investigations conducted included malaria microscopy and total leukocyte count.
Results: Eighty percent (308/382) employed at least one vector controlmeasures to prevent malaria infection, and majority 232 (75.2%) use only one control measure. The commonest control measures used included always keeping doors and windows shut 298 (96.7%) and/or netted 280 (90.9%), use of conventional insecticide sprays 183 (59.4%), use of insecticide treated bed nets (ITNs) 178 (57.8%) and ensuring child sleeps at night with body adequately covered 77(25%). Approximately half (178/315) of households who owned ITN used it, and only 40.4% (72/178) used it daily. It was noted that children that slept under an insecticide treated bed net (RR 0.56, 95% CI 0.33-0.94; P=0.029) and those who slept well covered at night (RR 0.26, 95% CI 0.12-0.61; P=0.002) had less risk of malaria infection. The use insecticide treated bed net however lost significance following adjustment for other control measures used and socio-demographic factors of interest (RR 0.63, 95% CI 0.36-1.10;P=0.101).
Conclusion: There is need to intensify education on appropriate malaria control measures especially proper use of insecticide-treated nets and suitable clothing during sleep at night.

Keywords: Malaria prevention, insecticide treated net, hospitalized children

Introduction

Malaria remains a major cause of mortality in Africa.[1] Ninety-seven percent of Nigeria's population are at risk of malaria and about 50% of Nigerians are estimated to have at least one episode of malaria annually.[2] Malaria is responsible for 60% of out patient visit to health facilities, 30% of under five mortality, 25% of infant mortality.[2]

The correct and timely application of the malaria control and prevention measures such as personal protection, drug use, and vector control strategies reduce the risk of malaria infection and transmission. Vector control plays a great role in malaria control and is one of the technical elements of the Global Malaria Control Strategy.[3] This is because the mosquito vector will either have no access to acquire the parasite from an infected person or transmit it to another person or, the mosquito vector dies with the parasite. The vector control methods are diverse but notable of use are insecticide treated nets (ITNs), indoor residual spraying of insecticides (IRS) and various environmental modifications.[4,5] ITNs were developed in the 1980s by treating nets with pyrethroid insecticides which not only reduces human–vector contact but further increases the protective efficacy of the mosquito nets by killing the malaria vectors that come into contact with it.[4] By reducing the vector population in this way, ITNs when used by a majority of the target population, provide protection for all people in a given community, including those who do not themselves sleep under nets.[4] Two types of ITNs exist: the conventionally treated nets and the long lasting insecticidal nets (LLINs).[4] Insecticides in the conventionally treated nets are effective for at least a year or after 3 washes while that of LLINs are effective for at least 5 years or 20 washes whichever comes first.[4] The WHO Global Malaria Programme (WHO/GMP) recommends distribution of ITNs, more specifically LLINs, to achieve full coverage of populations at risk of malaria.[4] The use of LLINs and scale up of IRS in Africa with improved diagnostic testing and treatment, has contributed to remarkable declines in malaria infection.[5,6] The National Malaria Control Strategic Plan (NMCSP) for 2009 to 2013 targeted that at least 80% of households own 2 or more ITN by 2010; at least at least 80% of pregnant women and children under 5 years sleep under ITN nightly by 2010.[7] According to the NMIS 2016, although the household ownership of at least 1 LLIN had improved from what it was in 2008, nationally, household ownership of at least 1 LLIN was 69% which is way below the target of 80% which should have been reached by 2010.[6] Also, households in the rural areas still owned at least 1 LLIN compared to their urban counterparts.[6] According to UNICEF,[8] across sub Saharan Africa, children living in urban areas are 1.5 times more likely to be sleeping under ITNs than those living in rural areas, and children in the wealthiest areas are 3 times more likely to be sleeping under bed net than those in the poorest areas.[8] The reverse of this trend was however seen in Nigeria.[6] About 5.5 lives can be saves each year for every 1000 children protected with an ITN.[9] ITN reduced incidence of uncomplicated malaria episodes by 50% compared to no nets in areas of stable malaria transmission and 39% compared to untreated nets in areas of unstable malaria transmission.[9] It also reduced severe malaria by 45%, hyper parasitaemia by 29% and splenomegaly by 30%.[9] It is therefore evident that proper use of ITNs would ultimately translate to the less hospitalizations secondary to malaria infections in children. This creates the need to sustain the control malaria transmission and to make early diagnosis with prompt treatment. Households are considered to be covered by vector control if they own at least one ITN.[8]

Entomologic inoculation rate which is the number of bites by infectious mosquitoes per unit time can profoundly affect symptomatic presentation of clinical disease.[1] Peak biting hours of *A. gambiae*t he predominant vector of malaria parasite in Nigeria was found to be between 1-2a.m and 2-3a.m in an African study.[10] Hence it can been considered that wearing full body clothing during these periods could prevent the vector from having its blood meal. Several environmental modifications which have been found to reduce the breeding of mosquitoes and its entrance into houses include use of insecticide treated bed nets, closing and screening doors and windows, proper refuse disposal, drainage of stagnant water and clearing of bushes.[6,11,12] However, no single method has been shown to effectively combat mosquito and malaria infection.[11,12] The study sought to appraise the different malaria control measures adopted by families of children presenting to the hospital with febrile illnesses in a sub-urban setting in south east Nigeria. It secondarily assessed the effect of use of these control measures on prevalence of malaria infection in these children.

Materials and methods

Study design and area

This study is a hospital based, cross-sectional descriptive study carried out between 2nd of June 2016 and 28th of January 2017 at Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, one of the two tertiary institutions in Anambra State. Nnewi is a commercial city located in Nnewi North Local Government Area. Nnewi is located on latitude 6º 01' N of the equator and longitude 6º 55' E of the Greenwich meridian.[13] It has a mean daily temperature of 30.4ºC, and mean annual rainfall of about 2000cm.[13] It falls within the tropical rain forest region of Nigeria.[13] It has 2 main seasons: the rainy season spanning from April to October, and the dry season spanning from November to March.[13] The Children Outpatient (CHOP) clinic of the NAUTH is not part of the General Outpatient clinic of the Hospital but under the Paediatric Department. Even though NAUTH is a tertiary institution which is supposed to be a referral centre, the CHOP clinic functions as a primary, secondary and tertiary care facility as many patients from the community present to the CHOP for the first time without any referral. About 6000 children present to NAUTH annually at the Children Emergency Room and Children Outpatient Clinic,[14] out of which about 80% are febrile.[15]

Study Population

The study population consisted of child and parent/caregiver pair. Children aged 6 months to 17 years who presented with fever at the CHOP clinic and CHER of the Hospital and the caregivers who brought them to the hospital was recruited. Inclusion Criteria included children aged 6 months to 17 years, children with axillary temperature $\geq 37.5^{0}$C or history of fever in the preceding 48hours,[16] children (<6 years) whose parents/caregivers gave consent and those (≥ 6 years) who gave assent to participate in the study. Excluded from the study were children whose caregivers refused to give consent for participation, children who had a complete dose of ACT in the extant illness as this may have completely eradicated the malaria parasites,[17] children who were treated for malaria at a tertiary centre in the preceding 2 weeks (this because the shortest incubation period of malaria parasite is about 2 weeks,[18] and tertiary hospitals are most likely to comply with the national guidelines on the treatment of malaria with ACT[18,19]), children on malaria prophylaxis prior to the onset of the extant illness.

Subjects' Recruitment and data collection

The number of subjects enrolled in this study was calculated using the Cochran formula for calculation of sample size based on a confidence interval of 95% which is equivalent to a confidence coefficient of 1.96, malaria prevalence of 20% in febrile children,[15] and a non-response rate of 5%. This gave a minimum sample size of 245, hence 382 children were recruited. The febrile children/caregiver pair were recruited consecutively using purposive sampling method. Once consent was given, the subject was screened by the investigators and/ or the research assistants. The screening determined who was recruited into the study. Those who fulfilled the inclusion criteria were recruited into the study. Each caregiver was given an information sheet about the study with explanation. Questionnaires were administered to caregiver by the investigator. The questionnaire was used to obtain information such as sociodemographic variables, history of the illness and malaria preventive measures used at home for the ill child.

Overview of management of febrile children in Paediatric unit

Following presentation to the CHOP, historical assessment, physical examination and laboratory test are done. For febrile children presenting through the CHER, initial resuscitation and stabilization measures were done. The diagnosis of malaria was made by demonstrating the presence plasmodium parasites in the peripheral blood by microscopy which is the gold standard.[20] Because the malaria microscopy result was not immediately available, the investigators performed malaria RDT for all the subjects to enable prompt diagnosis of those who had malaria. For positive malaria tests, a full course of ACT was given for uncomplicated malaria while those with complicated malaria were admitted for immediate treatment with intravenous artesunate and management of complication(s). Those who had negative malaria RDT results were further evaluated for other causes of febrile illness and managed accordingly. The subjects who had negative malaria RDT test results but were later found to have malaria parasitemia from the malaria microscopy were treated as outlined above if on admission or contacted over the phone within 24 hours for follow up if it was an outpatient visit. A full course of ACT was prescribed for them.

Measures

On presentation to the CHOP or CHER, the investigators performed a thorough general examination on each subject assessing for pallor on the palpebral conjunctiva, buccal mucosa, palms and soles. Axillary temperature was taken using a digital thermometer (Domotherm® Germany, 0.2˚C sensitivity). The tip of the thermometer was placed at the apex of the axilla and held in place with upper limb adducted till a beep was heard. The displayed reading, in centigrade to one decimal place was taken as the subject's temperature. Anthropometric measurements such as weight, height and body mass index were also measured.

Laboratory procedure

Two milliliters of blood were collected from each subject and put in an ethylene diamine tetracetic acid (EDTA) bottle, maintaining aseptic and universal safety precautions all through. A code number was assigned to each EDTA bottle. The blood collected was subjected to tests by a WHO certified laboratory scientist within 24 hours of collection. Each subject had the thick and thin blood film for malaria microscopy and total leukocyte count. Malaria parasite density was calculated using the following formula;

$$\frac{\text{Number of parasites counted} \times \text{Total leukocyte count}}{\text{Number of leukocytes counted}}$$

The parasite density was classified into the different parasite classes as thus:[20]i) Class 1- <50; ii) Class 2- 50 -<500; iii) Class 3-500 -<5000; iv) Class 4- 5000 -<50000 and v)Class 5 ≥50000.

Data Analysis

The data was cleaned and entered into Statistical Package for Social Sciences (SPSS) version 23 Chicago, IL for analysis. The predictor variables were analyzed as categorical variables. The outcome variable i.e. presence of malaria parasitaemia and parasite density were analyzed as both categorical and continuous variables. Binary logistic were performed in two levels. In the first level, control measures used by respondents were fitted into the logistic model to determine association between their use and malaria parasitemia in study subjects. In the second level, possible confounders were adjusted for to determine the non-biased relationship between malaria parasitemia and use of malaria control measures. Statistical significance was set at $p < 0.05$.

Ethical clearance

Ethical clearance was obtained from the Health Research and Ethics Committee of NAUTH Nnewi with reference number NAUTH/CS/66/VOL.7/44. Informed consent was obtained from each caregiver and assent from children who were 6 years and above.

Results

Characteristics of children enrolled for study

Of the children who presented to the CHOP and CHER during study period, 382 met the inclusion criteria and all consented to participate in the study giving a response rate of 100%. Of the 382 enrolled, slightly above half (53.1%) were children under the age of 5 year and about a fifth (22.5%) were between the age of 5 and 9 years old. The median age of enrolled children was 4.6 years with an inter-quartile range (IQR) of 1.8 to 9.6 years. There were three males to every two female children enrolled. Two hundred and seven (54.2%) of enrollees were resident in urban areas compared to 175 (45.8%) from rural settings. Close to a quarter of these children (28.0%) were from families in the low socio-economic strata. Only 112 (29.3%) of these children were brought or presented to the hospital on the day fever was noticed while the remainder (70.7%) waited 2 to 21 days after onset of fever. The median axillary temperature recorded and days between fever onset to hospital presentation was 37.8°C (IQR 36.9-38.5°C) and 3.0 days (IQR 1-5 days) respectively. The median axillary temperature at presentation for enrollees that presented on day 1 of fever (38.1°C, IQR 37.2-38.5) was significantly higher compared to those presenting later (37.7° C, IQR 36.8-38.0°C, *P*=0.015). Malaria parasite test was positive in 89 of the 382 children and parasite density was less than 5000 parasites per microliter of blood in 21 (22.6%), 5000-50,000 per µl in 37.1% and more than 50,000 per µl in 39.3% of participants. The median malaria parasite density seen on thick blood film was 27,510 parasites per µl (IQR 5735.0-97,830.5 per µl).

Pattern of malaria control measures

Table 2 shows the pattern of malaria control measures used on the febrile children by their parents and/or care givers. Eighty percent (308/382) of the respondents employed malaria control measures to prevent mosquito bites and consequent malaria infection in the index child with febrile illness. Majority of these, 232 (75.2%) use only one control measure while the remainder 68 (22.2%) and 8 (2.6%) use two and three or more measures respectively. Three hundred and fifteen (82.7%) of the respondent's households own an ITN, and roughly one-in-two, 189/382 (49.5%) of the study participants sleeps under a bed net, which included ordinary bed nets (i.e. non-insecticide treated) in 11/189 (5.8%) and insecticide treated bed nets in 178/ 189 (94.2%) all of which are LLIN.

The type of malaria control measure used by respondents was summarized in Table 3. Always keeping doors and windows shut 298 (96.7%) and/or netted 280 (90.9%) to prevent mosquitoes from entering into the living space were the commonest adopted method practiced by families of the respondents. Other less common methods included use of conventional insecticide sprays 183 (59.4%), use of insecticide treated bed nets 178 (57.8%) and ensuring child sleeps at night with body adequately covered 77 (25.0%).

Table 1: Characteristics of children seen for febrile illness at the children outpatient and emergency unit of the Nnamdi Azikiwe University Teaching Hospital Nnewi

S/N	Characteristic	Variable	No (n)	Percentage (%)
1.	Gender *(n=382)*	Male	230	60.2
		Female	152	39.8
2.	Age *(n=382)*	< 5 yrs	203	53.1
		5-9 yrs	86	22.5
		10-14 yrs	67	17.5
		15-17 yrs	26	6.8
3.	Place of residence *(n=382)*	Urban	207	54.2
		Rural	175	45.8
4.	Maternal education *(n=382)*	Primary or less	43	11.3
		Secondary	111	29.1
		Tertiary or higher	228	59.6
5.	Socio-economic class *(n=382)*	Low	107	28.0
		Middle	148	38.7
		High	127	33.3
6.	Duration of fever before Presentation to hospital *(n=382)*	≤ 1 day	112	29.3
		2-4 days	171	44.8
		5-9 days	75	19.6
		≥ 10 days	24	6.3
7.	Use of antimalarials before Presentation to hospital *(n=382)*	Yes	123	32.2
		No	259	67.8
8.	Malaria blood film result *(n=382)*	Negative	293	76.7
		Positive	89	23.3
9.	Malaria parasite density per µL *(n=89)*	Less than 5000	21	22.6
		5000-50,000	33	37.1
		More than 50,000	35	39.3

Table 2: Pattern of use of malaria control measures among febrile children seen at the outpatient and emergency unit of the Nnamdi Azikiwe University Teaching Hospital Nnewi

S/N	Parameter	Variable	No (n)	Percentage (%)
1	Do you use any malaria control measures for index febrile child *(n=382)*	No	74	19.4
		Yes	308	80.6
2	Number of control measures normally used for index febrile child *(n=308)*	1	232	75.2
		2	68	22.2
		≥ 3	8	2.6
3	Does your household own at least 1 ITN *(n=382)*	No	67	17.7
		Yes	315	82.3
3	Does index febrile child sleep under any type of bed net *(n=382)*	No	193	50.5
		Yes	189	49.5
4	Type of bed net index child sleeps under *(n=189)*	Non-insecticide treated	11	5.8
		Insecticide treated	178	94.2
5	Type of ITN *(n=178)*	Conventional ITN	0	0.0
		LLIN	178	100.0

Table 3: Malaria control measures used for febrile children encountered at the children outpatient and emergency unit of the Nnamdi Azikiwe University Teaching Hospital

S/N	Control measures†	Number (n) N=308	Percentages (%)
1.	Making sure doors and window are always shut	298	96.7
2.	Netting of window and door frames	280	90.9
3.	Use of conventional insecticide sprays	183	59.4
4.	Use of Insecticide treated bed net (ITNs)	178	57.8
5	Ensuring whole-body cloth covering at night	77	25.0
6.	Draining and clearing of stagnant waters in surroundings	18	5.8
7.	Frequent cleaning of environments and clearing of gutters	17	5.5
8.	Use of untreated bed net	11	3.6
9.	Application of mosquito-repellant lotions	10	3.2
10.	Burning of mosquito-repelling incense (coils)	9	2.9

† one or more control measures used by some respondents

Only about two-thirds 72/178 (40.5%) of those who sleep under an insecticide treated bed net use it every night, and this makes up only (72/382)18.8% of the total number of the participants. Table 4. About a fifth (16.3%) of the children, used ITN which was too old (>5years), damaged (torn), washed more than 20 times. More than half 178/315 (56.5%) of the families who owned ITN received it at their homes during ITN campaigns and about a third (35.6%) at public/ government owned health facilities, Fig 1. Of the ill children whose families owned ITN but did not regularly use it, majority 146/243 (60.1%) of their caregivers had no reason for not using it regularly, while 25(10.6%), 19 (7.8%), 15 (6.1%) respectively did not use it because the child felt too hot when it was used, reacted to it by itching/ difficulty breathing and the caregivers felt the mosquito density in their living area was negligible. Fig 2. The age of the children, the mother's highest educational level and family socioeconomic level did not affect the family's ownership of ITN. More of the under-five children 111/203 (54.4%) use ITN, and this was statistically higher compared to older age groups (χ^2=18.998, p=0.000). Similarly, more children whose mothers had tertiary education 120/228 (52.6%) and secondary education45/111 (40.5%) use ITN compared to those whose mothers had lower academic attainment and this was statistically significant (χ^2=9.79, p=0.020). Significantly higher number of children from middle SEC 81/148 (54.7%) and high SEC 59/127 (46.5%) use ITN compared to those from low SEC 38/107 (35.5%) χ^2=9.216, p=0.01. Table 5.

Malaria control measures and its effect on malaria infection rate in febrile children

The effect of use of various malaria control measures encountered among respondents on mosquito bites and consequent malaria transmission was assessed. It was noted that use of insecticide treated bed nets (*P*=0.001), use of mosquito coils (*P*=0.007), adequately covering of body (*P*=0.001) and prevention of collection stagnant water in surrounding (*P*=0.030) were significantly associated with malaria parasitemia in surveyed

children while other control measures were not. Table 6. Further analysis showed that only use of insecticide treated nets and whole body covering while sleeping at night were significantly predictive of incidence of malaria in the studied children. It was noted that children that slept under an insecticide treated bed net had half the risk of acquiring malaria infection relative to those that do not sleep under ITNs (RR 0.56, 95% CI 0.33-0.94; *P*=0.029) while children who slept well covered at night were 0.26 times less likely to be infected with malaria compared to those not well covered at night (RR 0.26, 95% CI 0.12-0.61; *P*=0.002). Put differently, , not being well covered during sleep at night increases the risk of malaria infection by a factor of four. However, on final binary logistic regression analysis, following adjusting for other control measures used and demographic factors of interest in this study, sleeping under insecticide lost significance as a predictor (RR 0.63, 95% CI 0.36-1.10; *P*=0.101) while adequate clothing covering body at night retained significance reducing the risk to 0.34 compared to children who do not wear adequate protective clothing during at night (RR 0.34, 95% CI 0.14-0.82; *P*=0.016). Table 7

Table 4: Pattern of use of ITN for the children practiced by the caregivers

Pattern of use of ITN *(n=178)*	Variable	Frequency	Percent
Usage of ITN	Nightly	72	40.4
	Not Nightly	106	59.6
Slept under an ITN previous night	Yes	81	45.5
	No	97	54.5
Age/condition of ITN	≥5 years/ damaged/ >20 washes	29	16.3
	<5 years/ undamaged/ < 20 washes	149	83.7
Retreated ITN	No	178	100.0
	Yes	0	0.0

Table 5: Cross-tabulation analysis showing association between household ownership and use of ITN by the children and their sociodemographic variables

Variable	Ownership of ITN No	Ownership of ITN Yes	Chi χ^2 (P)	Use of ITN No	Use of ITN Yes	Chi χ^2 (P)
Age						
<5 years (n=203)	29 (14.3)	174 (85.7)		92 (45.3)	111 (54.7)	
5- 9 years (n=86)	14 (16.3)	72 (83.7)	6.074† (0.108)	45 (52.3)	41 (47.7)	18.998 (0.000*)
10- 14 years (n=67)	16 (23.9)	51(76.1)		50 (74.6)	17 (25.4)	
15- 17 years (n=26)	8 (30.8)	18 (69.2)		17 (65.4)	9 (34.6)	
Maternal HEL						
No Formal education (n=6)	2 (33.3)	4 (66.7)		4 (66.7)	2 (33.3)	
Primary (n=37)	11 (29.7)	26 (70.3)	5.310† (0.150)	26 (70.3)	11 (29.7)	9.797† (0.020*)
Secondary (n=111)	20 (18.0)	91 (82.0)		66 (59.5)	45 (40.5)	
Tertiary (n=228)	34 (14.9)	194 (85.1)		108 (47.4)	120 (52.6)	
SEC						
Low (n=107)	25 (23.4)	82 (76.6)	4.068 (0.131)	69 (64.5)	38 (35.5)	9.216 (0.01*)
Middle (n=148)	25 (16.9)	123 (83.1)		67 (45.3)	81 (54.7)	
High (n=127)	17 (13.4)	110 (86.6)		58 (53.5)	59 (46.5)	

†Yates correction applied where applicable; *Statistically significant association

Table 6: Cross-tabulation analysis showing association between malaria parasitemia and malaria control measures used in febrile children

Control measure used	Variables	Blood film Malaria Parasite Negative	Positive	Chi-χ^2 (*P*)
Non-insecticide treated nets *(n=382)*	No	286 (77.3)	84 (22.7)	2.339
	Yes	7 (63.6)	5 (45.4)	(0.126)
Insecticide treated bed nets *(n=382)*	No	143 (70.1)	61 (29.9)	10.683*
	Yes	150 (84.3)	28 (15.7)	(0.001)
Windows and doors always shut at night *(n=382)*	No	60 (71.6)	24(28.4)	1.325
	Yes	232 (77.9)	66 (22.1)	(0.250)
Mosquito-repelling incense (coils) *(n=382)*	No	290 (77.7)	83 (22.3)	7.375*
	Yes	3 (33.3)	6 (66.7)	(0.007)
Mosquito-repelling lotions *(n=58)*	No	284 (76.3)	88 (23.7)	1.016
	Yes	9 (90.0)	1 (10.0)	(0.313)
Netting of doors and windows *(n=58)*	No	78 (76.5)	24 (23.5)	0.004
	Yes	215 (76.8)	65 (73.2)	(0.949)
Frequent gutter cleaning and clearing *(n=58)*	No	278 (76.2)	87 (23.3)	0.735
	Yes	15 (88.2)	2 (11.8)	(0.391)
Whole-body cloth covering at night *(n=58)*	No	223 (73.1)	82 (26.9)	10.893*
	Yes	70 (90.9)	7 (9.1)	(0.001)
Prevention of stagnant water in surrounding *(n=58)*	No	283 (77.7)	87 (22.3)	4.727*
	Yes	10 (55.6)	8 (44.4)	(0.030)
Insecticide spray *(n=58)*	No	155 (77.9)	44 (22.1)	0.328
	Yes	138 (75.4)	45 (24.6)	(0.567)

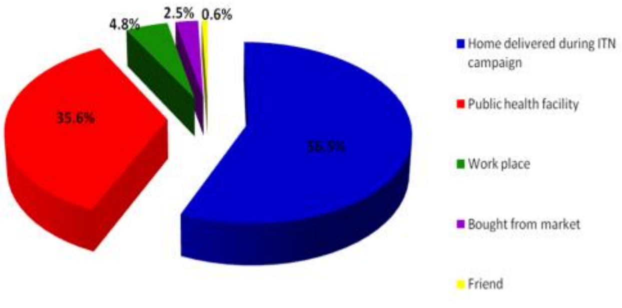
†Yates correction applied where applicable; *Statistically significant association

Table 7: Logistic regression analysis of malaria parasitemia and malaria control measures among children seen for febrile illnesses in children outpatient and emergency room

Control measures	Variables	Odd Ratio (95% Confidence Interval) Crude	p-value	Adjusted†	p-value
Sleeping under long-	No	1	--	1	--
acting insecticide treated nets	Yes	0.56 (0.33-0.94)	0.029	0.63 (0.36-1.10)	0.101
Use of mosquito coils	No	1	--	1	--
during sleep	Yes	4.28 (1.01-18.26)	0.050	4.22 (0.94-18.91)	0.060
Whole-body cloth covering	No	1	--	1	--
at night	Yes	0.26 (012-0.61)	0.002	0.34 (0.14-0.82)	0.016
Prevention of water	No	1	--	1	--
stagnation in surrounding	Yes	2.91 (0.98-8.65)	0.054	2.67 (0.84-8.49)	0.097

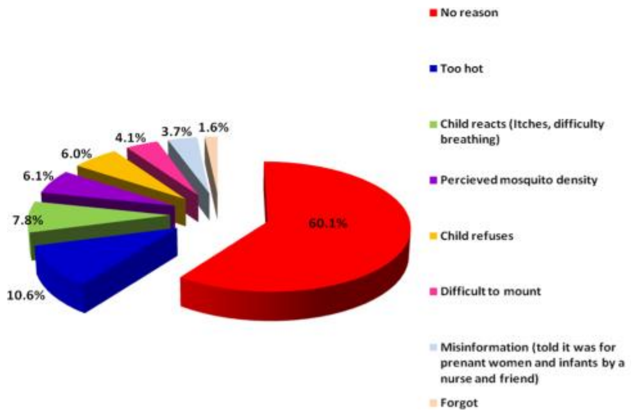
†Adjusted for use of other control measures, age, gender, socio-economic status, place of residence and prior use of anti-malarial; Bold *p* significant

Fig 1



Source of ITN owned by the subject's families

Fig 2



Discussion

There is a global decline in the prevalence of malaria following numerous control efforts. Vector control is the most effective malaria control measure as it not only protects the index person, but also the community by extension, hence is key to the Global Malaria Control Strategy as well as the National Malaria Strategic Plan.[2,3] Majority of the caregivers in this study used a form of vector control measure in a bid to prevent malaria in the index child as well as the household. The commonest measure used were closing of the doors and windows at night, netting of the doors and windows, use of ITN and insecticide sprays. The common use of these control methods have been reported in studies done in the South-western part of Nigeria.[22,23] Although locally accepted, these control measures may give a false sense of protection among families and care-givers thus preventing utilization of the standard recommended measures such as ITNs and good environmental sanitations.

For instance, mosquito coils used by some caregivers apart from been ineffective, have been shown to be an environmental pollutant as well as a significant health hazard. Very few of these respondents used multiple control measures (≥ 3) at a time. This is contrary to the current focus of integrated vector control advocated by WHO which promotes application of different interventions in combination and in synergy with each other.[24] LLIN ownership and use are proven interventions adopted by the RBM partners and the Nigeria FMoH.[3,8] Household ownership of ITNs was high in this study and there was no significant difference in the ownership of ITN amongst the households irrespective of the age of the children, the mother's highest educational level, the family's socioeconomic class or their place of residence. This may be because of the vigorous campaign on malaria prevention done between 2008 and 2016 by the State Malaria Elimination Programme (SMEP) in collaboration with Support for National Malaria Prevention (SuNMaP) and its partners in Anambra State, aimed at free mass distribution of LLINs amongst other actions.[25] The SuNMaP campaign was said to have improved ownership of LLIN in Anambra State from 2% in 2009 to 64.8% in 2014.[25] This is even lower than the 82.5% found in this study although this study was hospital based while that of the SuNMaP partners was community based where higher figures are expected. The household ownership of ITN observed in this study is also higher than 73.5% reported in Anambra State and

also higher than 73.5% reported in Anambra State and 69% reported nationally by the NMIS as at 2015.[6] This improvement may be because of the continued LLIN distribution in the State government. Majority of the respondents in this study received their LLIN freely from the Anambra State government, which was delivered to them at their houses, or given to them at antenatal and immunization clinics. This supports the assertion by the SuNMaP campaign that LLINs were distributed to people at their homes, antenatal and immunization clinics as well as offices and churches.[25]

Despite the 82.6% ownership of ITNs in this study, it was used by about half of the caregivers for the children, and there was even greater gap between its ownership ant daily use which is recommended for malaria protection. NMIS also reported low daily ITN usage of 24.1% in Anambra State notwithstanding 73.5% ownership, which is comparable to 18.8% ITN usage found in this study.[8] This gap in ITN ownership and use was also reported in other local studies.[22,23] It is noteworthy that ITNs were significantly used more by under-fives, children of mothers with higher educational status and from families from middle and high socioeconomic class (SEC). This finding was also reported in Nigeria and other African countries.[6,26,27] It higher use in younger children may be due to the usual perception that the younger age groups were at a higher risk of the disease. Also the mothers of younger children were more likely to visit to the antenatal or immunization clinics which were avenues for free ITN distribution as well as education of the caregivers on health related matters. Contrary to our finding, it was reported at in a tertiary hospital in Benin Nigeria that children from the low SEC used ITNs more.[22] More than half of the caregivers whose household owned ITN had no reason for not using it, and about a tenth suggested hot environmental temperature as a reason. This was also reported by Nwaneri *et al*.[22] This is a worrisome trend in Anambra State as the campaigns seemed to have focused more on free distribution of ITN, and may have neglected education of the masses on the most effective way to use them. If mass campaign on the appropriate use of ITNs is initiated, it is likely to have a huge impact on malaria control in the State as many households already own them.

Finally, we reported that use of insecticide treated bed nets and adequate body clothing significantly reduced malaria infection rate among surveyed children. While the former has also been reported in several studies,[6,28,29] the latter has not been extensively studied. However, a study conducted on European tourists visiting malaria endemic regions of Africa showed that regular use of personal protective measures such as air-conditioned rooms and clothing which covered arms and legs resulted in a small, but significant reduction of malaria incidence when travelers were interviewed 12 weeks after returning home, whereas repellants, insecticides, coils, etc. showed no significant effect. The study concluded that the use of personal protective measures should be encouraged on people who are at greatest risk of mosquito bites, and thus of malaria.[30] It is worth mentioning that the use of ITNs lost significance when certain parameters related to use of other control measures and socio-demographic parameters of respondents was factored into the equation. Thus, even though the protective effect of insecticide-treated nets is well documented, other factors (such as proper use, frequency of usage, environmental conditions etc.) affects its effectiveness. This was not true for the use of adequate protective body clothing which retained significance even after adjusting for all these factors.

Limitations

The main limitation of our study lies in the inherent constraint of cross-sectional studies that restricts the ability to infer causality between control measures and malaria infection among surveyed children.

Conclusion/recommendation

The prevalence of malaria in febrile children is high in our setting. The commonest malaria control measures used by families of febrile children are not only unconventional but also ineffective in preventing mosquito contact and the ensuing malaria infection. The utilization of insecticide-treated bed nets among respondents was grossly inadequate both in frequency of usage and its correct application. There is therefore need for sustained and concerted efforts to enlighten families and care-givers on uptake and proper usage of insecticide treated bed nets in addition to proper clothing of children during sleep.

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