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Insecticide Treated Net usage among under-five Children in South-West Nigeria

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Abstract
Relevance of Insecticide Treated Nets (ITNs) in reducing the malaria scourge among most vulnerable groups has been reported. This study uses data from 2018 Nigeria Demographic Health Survey (NDHS) to assess utilization among under-five children in South-West of Nigeria, a region with lowest utilization in the country. The study aims at assessing effect of some covariates on utilization of ITNs among children under the age of five in South-West Nigeria. Binary logistic regression is used to assess effect of covariates on response variable and the chi-square test is used to assess dependency of some socio-demographic factors. All factors considered are significant to the response variable except the gender of the child. Utilization is mostly limited because of heat generated by the net and the irritating effects of usage. Rural dwellers are found to have an insignificant higher odds of sleeping under ITN compared to those in urban areas. Lagos state has the lowest utilization rate among states in the region while Ekiti has the highest. Children with fever two weeks preceding the survey have higher odds of sleeping under ITN. Utilization is highest among the *poorest* with odds of usage more than six times higher than those in *richest* wealth index category. For any intervention programme especially among the under-five children, identifying most important areas that will maximize efficiency and effectiveness of usually insufficient resources is very crucial. Attempts are to be made in educating caregivers on importance of utilizing ITN rather than the usual ownership sensitization.
Keywords: Insecticide treated nets; under five children; binary logistic regression, Malaria, South-West Nigeria.

1. Introduction

In Africa, malaria has been reported to be a major cause of child mortality (Lengeler, 2004; WHO, 2015). According to WHO, children under 5 years remain the most vulnerable group affected by the scourge of malaria with about 266,000 (61%) of all global deaths in 2017 (WHO, 2018). India and 19 sub-Saharan Africa countries carries about 85% global burden of malaria with Nigeria alone having about 25% (WHO, 2019). While global deaths due to malaria is declining in recent years from above 600,000 in 2010 to about 450,000 in 2016 and 435,000 in 2017, African countries accounts for about 93% global malaria deaths in 2017 with Nigeria alone accounting for 19% of the global mortality (WHO, 2018).

From 72 cases per 1000 population at risk in 2010, the incidence rate of global malaria burden reduced to 59 cases per 1000 in 2017 but in Africa, it is still about 219 cases per 1000 (WHO, 2018). Countries in Africa accounts for 92% of about 219 million cases of malaria reported worldwide in 2017 with Nigeria alone having 25% of all these cases (WHO, 2018). While other African countries like Rwanda (430,000 fewer cases) and Ethiopia (240,000 fewer cases) recorded decline in malaria burden in 2017 compared to 2016, the number of reported cases in Nigeria is on the increase (WHO, 2018). The Roll Back Malaria programme (RBM, 2001) introduced to reduce the scourge identified children under 5 years as one of the highest risk groups for malaria, and one of the strategies set to fight malaria in this group is to increase utilization of mosquito nets (Sibhatu *et al*., 2012). In preventive medicine, Insecticide Treated Nets (ITNs) usage among pregnant women has been reported to reduce incidence of malaria during pregnancy and hence reduce various complications due to pregnancy such as premature deliveries, low birth weight babies, maternal anaemia and intra uterine foetal deaths (Mboera *et al.* 2007; Koudou *et al.,* 2010). ITN is the core recommended intervention to prevent mosquito bites by the WHO (WHO, 2018; WHO, 2019). It remains number one preventive and cost effective measure against malaria globally with reported effectiveness in most of malaria-endemic regions (Malaria Consortium, 2016). From the investment of US$ 1.6 billion made on ma
laria prevention commodities in 2014, above 60% was spent on ITNs (WHO, 2015). Over 600 million ITNs were delivered globally between 2015 and 2017. 83% of these deliveries were made in sub-Saharan Africa. In Nigeria, the National Malaria Elimination Program (NMEP) and its partners distributed more than 72 million ITNs from 2013 to 2018 and the Nigeria Malaria Indicator Surveys (NMIS) showed that at national level, ownership of at least one ITN in a household increased from 8% to 69% from 2010 to 2015 (NMOP, 2019).

Despite the reported effectiveness of ITNs in reducing malaria morbidity and mortality in children, utilization is still quite low (Murphy & Bremen, 2001; WHO, 2006). Studies on effectiveness of ITNs in sub-Saharan Africa

showed that correct use of ITNs among children under-five reduces mortality (RBM, 2001; Harvey *et al.,* 2008). In Kenya for example, effective ITNs utilization was reported to save about 35 lives in every 1,000 (Alaii *et al.,* 2003)

In Nigeria, the 2015 Nigeria Malaria Indicator Survey (NMIS), a programme implemented by the National Malaria Elimination Programme (NMEP), the National Population Commission (NPC), and the National Bureau of Statistics (NBS) reported states in South-West have the least ITNs ownership (NMEP, 2016). The geo-political zone is also reported to have the least utilization in the country with only 22% usage by children under the age of five and pregnant women (NMEP, 2016). This is a very disturbing contrast when compared with North-West for example with 62% utilization among children and pregnant women.

This study assesses some deterring factors for the utilization of the ITN among states in South-West, Nigeria. The target population are the caregivers for the under five children within the geo-political zone. This is expected to contribute to the understanding of factors that affect the use of ITNs. Also, it is expected that the study would be a source of information to various Non-Governmental Organizations, government and private enterprises who are involved in the eradication of malaria, especially among pregnant women and children under the age of five within South-West of Nigeria.

2. Material

2.1 Data

Data from the 2018 Nigeria Demographic Health Surveys (NDHS) is utilized in the study. DHS are country-specific household surveys with data on wide range of indicators on health and socio-economic indicators and are conducted once every 5 years. Special attention is given to under-five children and women (aged between 15 and 49 years). The DHS uses the Malaria Indicator Survey (MIS) to obtain information from representative sample of respondents using questionnaires and manuals in different countries across the world. MIS obtain data on household ownership of insecticide treated nets (ITN), especially their usage by under-five children and pregnant women.

2.2 Study Area

South-West *(figure 1a)* is one of the geo-political zones in Nigeria with six states of Ekiti, Lagos, Ogun, Ondo Osun, and Oyo states. It is majorly an agrarian region except Lagos state which is a metropolitan state and the commercial nerve centre of the country. The region is bounded in the East by Edo and Delta states, in the west by Benin Republic, in the north by Kwara and Kogi states and in the south by the Gulf of Guinea. Full Nigeria map indicating states in South-West is shown in *figure 1b*

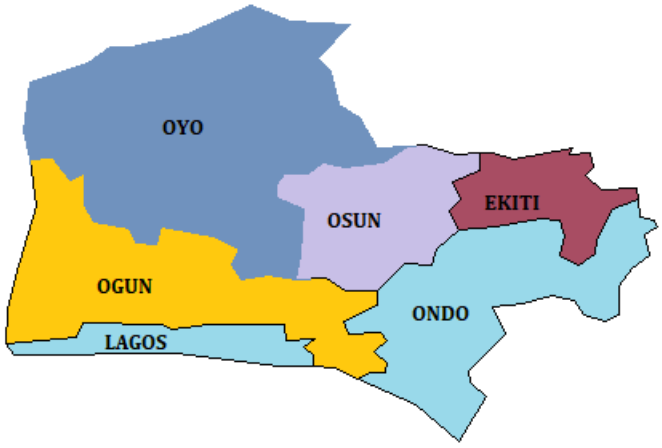

Figure 1a: States in South-West, Nigeria

Figure 1b: Map of Nigeria showing States in South-West

3. Methods

The response variable in the study is the response of caregivers on the utilization of ITN for children under-five a night before the survey with a binary (Yes/No) outcome. The relationship between ITN utilization and factors considered in the study is considered using chi-square test of independence. Bivariate logistic regression model is then used to predict the odds of utilizing ITN.

Binary logistic regression model is the most common method to analyze binary response variable (Adejumo & Adetunji, 2013). It is used to model relationships between response variable and several explanatory variables, which may be discrete or continuous. For analysis purpose, two levels of the response variable is denoted by 0 and 1 ("No/Yes"). Efficiency of logistic regression has been proven in analyzing categorical data (Fahrmeir & Tutz, 2001; Hosmer & Lemeshow, 2001).

The response variable is defined as:

$$Y = \begin{cases} 1, & \text{if the ITN is utilized} \\ 0, & \text{if the ITN is not utilized} \end{cases}$$

with probabilities $P(Y = 1) = \pi$ and $P(Y = 0) = 1 - \pi$. If X_i is set of variable that is either categorical or continuous and $Y_i = 1$ for the occurrence of an event (utilization of ITN) of interest and 0 if otherwise then,

$$P_i = \left(\frac{1}{1+e^{-Z}}\right) \quad (1)$$

Where $Z = \beta_0 + \beta_1 X_{1i} + \cdots + \beta_k X_{1k}$

Equation (1) is the cumulative logistic distribution function. To fit a binary logistic regression model, a set of regression coefficients that predict the probability of the outcome of interest are estimated. Given probability of utilizing ITN as p_i and $1\text{-}p_i$ for not using ITN, the probabilities results in a linear combination as:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k \quad (2)$$

Equation (2) has been used extensively in literatures (Adejumo & Adetunji, 2013; Mohlabane *et al.,* 2016; Onemayin *et al.,* 2020). Coefficients of the logistic model tell how much the logit changes based on the values of the predictor variables. Given the covariates, equation (3) specify the probability of the utilizing ITN.

$$\pi_i = \frac{\exp(\beta_{i0} + \beta_{i1}x_{i1} + \cdots + \beta_{ip}x_{ip})}{1 + \exp(\beta_{i0} + \beta_{i1}x_{i1} + \cdots + \beta_{ip}x_{ip})} \quad (3)$$

4. Results

The frequency and chi-square test of dependency of socio-demographic variables considered in the study are presented in table 1. All factors are significant to the response variable except the gender of the child. Table 2 shows that most of the ITNs are obtained from *Campaign* while least number are obtained from *immunization*.

Table 1: Socio-demographic characteristics of respondents and *an ITN utilization*

Characteristics	***ITN utilization***		***Chi-Square P-value (α=5%)***
	No 5646 (79.4%)	***Yes 1466 (20.6%)***	
Place of residence			
Urban	3638 (81.4%)	829 (18.6%)	*0.000**
Rural	2008 (75.9%)	637 (24.1%)	
State			
Oyo	906 (72.8%)	339 (27.2%)	
Osun	929 (79.5%)	239 (20.5%)	
Ekiti	910 (75.5%)	295 (24.5%)	*0.000**
Ondo	1006 (81.9%)	222 (18.1%)	
Lagos	1039 (86.3%)	165 (13.7%)	
Ogun	856 (80.6%)	206 (19.4%)	
Gender of the child			
Male	463 (75.7%)	149 (24.3%)	*0.727*
Female	485 (76.5%)	149 (23.5%)	
Child has fever in last 2 weeks			
Yes	4474 (79.7%)	1142 (20.3%)	*0.026**
No	1139 (78.8%)	306 (21.2%)	
Don't know	33 (64.7%)	18 (35.5%)	
Has Electricity			
No	1503 (76.3%)	468 (23.7%)	*0.000**
Yes	4143 (80.6%)	998 (19.4%)	
Wealth Index			
Poorest	158 (69.6%)	69 (30.4%)	
Poorer	537 (79.3%)	140 (20.7%)	*0.000**
Middle	963 (74.8%)	325 (25.2%)	
Richer	1727 (79.9%)	435 (20.1%)	
Richest	2261 (82.0%)	497 (18.0%)	
Mother's level of education			
No formal education	158 (79.8%)	40 (20.2%)	
Primary	136 (70.8%)	56 (29.2%)	*0.007**
Secondary	401 (77.3%)	118 (22.7%)	
Tertiary Education	111 (66.5%)	56 (33.5%)	

* *Significant factors at α = 0.05*

With highest response rate (13.9%), utilization of ITNs is mostly limited because of *heat generated by the net* while the *colour of the net* is the least among factors that would encourage utilization with 0.7% response (table 3).

Table 2: How net was obtained

Characteristics	***Frequency***	***ITN utilization***		***Chi-Square P-value (α=5%)***
		No (5646)	***Yes (1466)***	
Bought	211	80	131	
Campaign	1166	0	1166	*0.000**
Ante Natal Clinic	114	15	99	
Immunization	88	18	70	

* *Significant factors at α = 0.05*

Table 3: Factors that would encourage more ITN usage.

Factor	***Frequency***	***Rank***
Ease of hanging	***Total (%)***	
No	6916 (97.2%)	**4**
Yes	196 (2.8%)	
Reduction in heat generated by the net	***Total (%)***	
No	6124 (86.1%)	**1**
Yes	988 (13.9%)	
If net do not smell	***Total (%)***	
No	6892 (96.9%)	**3**
Yes	220 (3.1%)	
Changing the colour	***Total (%)***	
No	7059 (99.3%)	**6**
Yes	53 (0.7%)	
If not irritating	***Total (%)***	
No	6807 (95.7%)	**2**
Yes	305 (4.3%)	
If made bigger/more comfortable	***Total (%)***	
No	7045 (99.1%)	**5**
Yes	67 (0.9%)	

From table 4, among factors that deter utilization, *access to ITNs* is ranked first. This is followed by *Cost of obtaining the net* while *absence of mosquito* is ranked least.

Table 4: Factors that deter ITN usage

Factor	***Frequency***	***Rank***
Absence of mosquito	***Total (%)***	
No	6965 (97.9%)	**4**
Yes	147 (2.1%)	
Access to ITN is not easy	***Total (%)***	
No	5124 (72.0%)	**1**
Yes	1988 (28.0%)	
Dislike for ITN	***Total (%)***	
No	6891 (96.9%)	**3**
Yes	221 (3.1%)	
Cost of obtaining the net	***Total (%)***	
No	6720 (99.3%)	**2**
Yes	392 (5.5%)	

Examining socio-demographic characteristics of respondents on "*Child ever slept under ITN*" table 5 presents the result of logistic regression. It is observed that male children have higher but insignificant odds of sleeping under ITN compared to female. Also, children that resides in rural areas are found to have higher odds of sleeping under ITN compared to those in urban areas. Those with fever two weeks preceding the survey also have higher odds of sleeping under ITN compared to those without. Utilization of ITN is highest among the *poorest* with odds of usage above six times higher than those in *richest* index category, *middle* class category has above four times odds of utilization, *poorer* category has above two times. Generally, results reveal that utilization is lower amongst people in higher wealth index category. Since most of these people reside in urban arrears, the result corroborates findings of lower utilization among residents of urban areas.

Table 5: Logistic regression of ***ITN utilization*** on some factors

Factor	P-value	Odds Ratio (OR)	95% C.I. for OR
Gender			
Female (reference category)		1.000	
Male	0.747	1.049	(0.785, 1.401)
Place of residence			
Rural (reference category)		1.000	
Urban	0.064	0.694	(0.471, 1.022)
State	0.000*		
Ogun (reference category)		1.000	
Oyo	0.119	1.559	(0.891, 2.728)
Osun	0.561	1.185	(0.668, 2.102)
Ekiti	0.031*	1.787	(1.055, 3.027)
Ondo	0.643	0.884	(0.527, 1.485)
Lagos	0.407	0.790	(0.453, 1.379)
Child has fever in the last 2 weeks			
No (reference category)		1.000	
Yes	0.603	1.094	(0.779, 1.537)
Wealth Index	0.007*		
Richest (reference category)		1.000	
Poorest	0.017*	6.156	(1.391, 27.251)
Poorer	0.073	2.763	(0.909, 8.396)
Middle	0.001*	4.252	(1.837, 9.839)
Richer	0.057	1.591	(0.986, 2.569)
Mother's level of education	0.006*		
No formal education (ref. category)		1.000	
Primary	0.002*	0.378	(0.202, 0.707)
Secondary	0.105	0.642	(0.375, 1.097)
Tertiary	0.003*	0.527	(0.345, 0.805)
Constant	0.999	895669569.412	

**Significant factors at α = 0.05*

Among the six states, the odds of a child under-five sleeping under ITN is highest in Ekiti state, followed by Oyo state. Ogun and Ondo states have relatively lower ITN utilization when compared with Ogun state while Lagos state has the least. Apart from Ekiti state with a significant utilization, there is no significant difference in utilization amongst all other five states. ITN utilization for children under-five is also found to be highest among mothers with *no formal education,* while those with primary education has the least odds of utilization.

5. Discussion

Importance of effective utilization of ITNs among children in combating malaria has been discussed (RBM, 2001; Harvey *et al.,* 2008; Gayawan *et al.,* 2014). From 7112 surveyed households in this, only 20.6% use ITN for children under 5 years. Although nets ownership is not explored in this study, a similar study reported low utilization of nets despite ownership (Komomo *et al.,* 2016). Utilization is found to be higher in rural area (24.1%) than urban area (18.6%). This supports the earlier findings where both ownership and utilization are reported to be significantly higher in rural residence (Osuorah *et al.,* 2013). Residing in urban centres requires higher standard of living where households are usually air-conditioned and hence the need for ITN may usually not arise. Low utilization in urban areas can also be related to the activities of the National Malaria Control Programme (NMCP) in Nigeria which include distribution of free ITN. This is more profound in rural areas with its attendance low standard of living (Oresanya *et al.,* 2008). Among the surveyed children, nets utilization is highest among those from *Poorest* households (30.4%) while it is least among the *Richest* (18.0%). The odds of a child from *Poorest* household using net is more than six times the odds of another child from the *Richest* household. All these point to the fact that standard of living of people living in rural areas is usually inferior when compared to those living in urban areas. This is also supported by the finding that children in households without electricity utilize ITNs more (23.7%) than those with electricity (19.4%)

With only 13.7% utilization, Lagos state has the least usage among the six states in the region. Low utilization of

ITN had been reported in the state despite high level of awareness on relevance of ITN (Aina & Ayeni, 2011). This may be unconnected with the fact that Lagos state is the commercial nerve centre of the country and the standard of living is very high in comparison with other states in the region. Therefore, the need for utilizing ITN may not arise for most residents. No significant difference in utilization between male (24.3%) and female (23.5%) children and utilization is higher among children with no fever (21.2%) two weeks preceding the survey when compared with those who had fever (20.3%).

Earlier study on women literacy and health practice reveals a positive association between the two (Osibogun *et al.,* 2000) and researches had also shown a significant relationship in nets utilization and educational status of mother (Noor *et al.,* 2006; Sebanjo *et al.,* 2006). This study also found that children whose mothers have tertiary or post-secondary education have highest utilization with 33.5% while those with *No formal education* (20.2%) have the least. Among considered factors that would encourage utilization, "*reduction in heat generated by the net*" is rated first while *size of the net* is the least. This supports similar findings from Abuja, Nigeria (Ashikeni *et al.,* 2013).

6. Conclusion and Recommendation

In implementing any intervention programme, it is highly essential to identify most important areas that will maximize efficiency and effectiveness of usually insufficient resources. This paper has examined some socio-economic factors in South-West of Nigeria as they affect utilization of the insecticide treated nets. Results from the analysis show that utilization is lower in urban areas compared to rural areas. This implies that people in urban centres do not see ITN as a major preventive instrument that could reduce malaria among the vulnerable. Another factor that could be associated with this is that most agencies involved in distribution of ITN usually focus on rural areas and those in need of the net in urban centre may have to result into purchasing. This may in turn deter utilization among those in urban centres.

There should also be an improvement in research and development of new cost effective insecticides to reduce growing resistance. To achieve universal coverage of ITNs, their regular and correct use must be promoted.

Funding remains a key issue in combating malaria globally. To achieve the Global Technical Strategy (GTS) for malaria 2016–2030, WHO (2018) recommended a budget of at least US$ 6.6 billion per year by 2020 but as at 2016, record showed spending of only US$ 588 million. Therefore, there should be an upward review of investment in the procurement and distribution of ITNs by government agencies and donors.

Based on the findings in the study, it is therefore recommended that various programmes by agencies of government and non-governmental organizations should improve modalities for distribution in hospitals in urban centres. Results also show that most respondent do not find it easy to access ITN and this is ranked first among deterring factors for utilization. Hence, policy makers are advised to make concerted efforts towards increased provision for ITNs. This will invariably increase utilization among the vulnerable will increase.

Two major factors identified that would encourage utilization are reduction in heat generated and reduction in irritating smell. Therefore, researches towards reduction in the heat generated by the nets and usage of friendlier odour in preparing chemical used for treating the nets should be encouraged by those producing the nets.

A record 85% of global distribution of ITNs were made through free mass distribution campaigns. (Komomo *et al.,* 2016) reported high disparities between ownership and utilization, efforts should be made to ensure recipients of these nets were properly enlightened on the relevance of effective utilization. Distribution of ITNs has hugely been financed by multilateral agencies and donor countries. In 2015, the Global Fund to Fight AIDS, Tuberculosis and Malaria distributed 600 million ITNs majorly in African countries (Global Fund, 2015). To ensure sustainability in procurement and distribution of ITNs, donor agencies need to continue providing supports while various governments of malaria endemic countries should also increase funding and improve on malaria evaluation and monitoring systems. In this study, nets obtain through campaigns, ante-natal clinic and immunization have highest utilization for children under five. These modes of distribution should therefore be improved upon in order to increase utilization.

Authors' contributions

AA conceived and designed the study, performed analysis and interpretation of data. JA and NG assisted with the design, interpretation of data, and drafted the paper. All authors did the critical review of the paper, read and correct the manuscript before submission.

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