# Households' Access to Insecticide Treated Nets (ITN) and Malaria Morbidity in Rural Nigeria: A Two-Stage Least Square Approach

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**Abstract:** The burdens of malaria on economic development of many tropical countries cannot be overemphasized. Introduction of ITN is a major effort by international bodies to reduce the problem. This study analysed the inter-relationship between access to ITN and malaria morbidity. Data from the 2008 Demographic and Health Survey (DHS) were used and analyses were carried out using descriptive statistics and Two Stage Least Square. Results show that presence of pregnant women in the household, household size, north east, south east, and south south regions, number of children 5 years and under, age of household head, sex of household head, educational status, listening to radio, read newspaper, occupation, electricity, one room for sleeping in the household and marital status significantly influence access to ITN ($p<0.10$), while presence of a pregnant woman and number of children five years and under increased reported malaria morbidity. It was concluded that access to ITN may not translate into reduction of malaria morbidity, depending on the usage and exposure of household members to mosquito bites outside the nets. Efforts at reducing malaria morbidity should therefore focus on media interventions in providing complete information on malaria prevention.
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**Keyword**: ITN, malaria, morbidity, mosquito

## 1. Introduction

The burden of malaria is a major threat to economic development in many developing countries. Human domestic and production activities including agriculture have been recognized as one of the reasons for increased intensity of malaria morbidity. This is as a result of their encouraging breeding of mosquitoes that carry malaria parasites (Asenso-Okyere et al 2009). In Nigeria, FMoH and NMCP (2009) noted that about 110 million medically diagnosed cases of malaria are recently reported annually. Malaria is also responsible for about 60 percents of outpatient hospital visits and about 30 percent hospitalization. It was further asserted that malaria is responsible for death of about 300,000 children annually, while contributing about 11 percent mortality among mothers, 25 percent mortality among infants, and 30 percent mortality among children less than five years of age. Economic cost of malaria is to the tune of ₦132 billion which form costs associated with treatment costs, prevention and loss of work time, among others (FMoH and NMCP 2009).

Malaria has been called the major disease of the poor. It is an aspect of ill health that negatively affects adult productivity and hampers accumulation of human capital in younger generations (Asenso-Okyere et al 2009). Malaria causes illness (morbidity), disability, or death and these can affect labour or resource use productivity. Because of current labour shortages in farm labour in many Nigerian rural areas, morbidity as a result of malaria infection and caretaking role by family members adversely affect agricultural productivity and production. It had been said that malaria reoccurrence in agrarian households would cause a decline in farm output and farm income, and cause food insecurity and increase in poverty (ESPD 2005). A United Nation's research report observed that smallholder farmers in Africa shoulder the heaviest burden of malaria because their margin of survival is very small due to several limitations associated with available health service delivery systems. It was emphasized that if there is a brief period of illness that brings about delays in crop planting or harvesting, severe economic consequences may result (UN Millennium Project 2005).

Egan (2001) also added that because malaria strikes during the rainy/harvest season, when workers' productivity needs to be at its peak, the disease can endanger agricultural production leading to transient or chronic food insecurity and reduction in farm incomes. Another potential impact is reduction in farm investments as a result of high expenditures on malaria treatment and prevention. Therefore, farm households may have to spend their

savings, sell productive assets or borrow money to pay for the treatment costs which are often repeated as morbidity reoccurs among some other household members (Asenso-Okyere et al 2009).

Malaria prevention and control have received the attention of international communities. It should be noted that over the years, there have been several global initiatives to control malaria. The Roll Back Malaria and the Abuja Declaration amongst others were attempts to coordinate policy makers' efforts and provide more resources to reduce the malaria burden in the world. The strategies used aimed at primary prevention through vector control or use of personal preventive methods such as bed nets, mosquito repellants, chemoprophylaxis and effective case management and medication.

The use of insecticide treated nets (ITNs) is presently considered the most cost effective method of malaria prevention in area where malaria is intense (Gikandi et al 2008; Noor et al 2007). Insecticide treated mosquito nets play a very important role in the prevention of malaria. Trials in Africa show that treated mosquito nets reduce the number of deaths among children aged less than five years by about 20 percent. Treating mosquito net with an insecticide will kill mosquitoes and other disease-spreading insects when they make contact with the net. An insecticide treated mosquito net also acts as an insect repellent, reducing the number of mosquitoes in the surrounding area. This helps to control the population of malaria-spreading mosquitoes and protects people from their infectious bites.

The pyrethroid insecticides that are used to treat mosquito nets have an excito-repellent effect that adds a chemical barrier to the physical barrier. This further reduces human vector contacts and increases the protective efficacy of the mosquito nets. If the vector population is reduced in this way, ITNs provide protection for all the people in the community, including those who do not themselves sleep under the nets (Binka et al 1998; Hawley et al. 2003). Studies have also shown that relatively modest coverage (around 60 percent) of all adults and children can achieve equitable community wide benefits. ITNs thus work in this case as a vector control intervention for reducing malaria transmission. ITNs have been shown to avert around 50 percent of malaria cases. This makes its protective efficacy to be significantly higher than that of untreated nets (Clarke 2007). ITNs were recently added as a malaria control policy in Nigeria and the government wishes to scale up its use.

In 1998, the World Health Organisation (WHO) launched the Roll Back malaria and one of its primary objectives was to increase ITN coverage to over 60 percent by 2005. This was later revised to 80 percent coverage by 2015. However, most African countries recorded low levels of ITN coverage (Abdulla et al 2002; Nathan et al 2004; Onwujekwe et al 2003 and Schellenberg et al 2002). Hence, it was important to assess factors influencing access to ITN and its implication on malaria morbidity.

Widespread distribution and use of insecticide-treated nets (ITNs) for the control of malaria has been a challenge facing Nigeria. The Africa Malaria Report shows that many countries are quite far from reaching the target of 60% ITNs coverage in sub-Saharan African countries by the year 2005, which was set in Abuja by the African Heads of State for the provision of ITNs to children under five and to pregnant women. Malaria, being the number one public health problem in Nigeria requires effective preventive efforts. Therefore, based on expected efficacy and efficiency, ITNs reduce the need for malaria treatments and the pressure on health services.

Ensuring high coverage of ITNs, especially in rural areas remains a topical issue in Nigeria. The public health care system was initially used to distribute ITNs in Nigeria, but the coverage was quite low. Commercial sector distribution and social marketing of ITNs is being promoted in some states in Nigeria, but the coverage remains low. Community-based distribution has not been tried on a large scale, but it could possibly be added to existing strategies to successfully distribute and scale-up ITNs in rural areas (Onwujekwe et al 2005). Increasing the coverage of ITNs among vulnerable populations is perhaps one of the most important mechanisms for effective malaria control (Chuma et al 2010).

The foregoing raises two research questions which this study seeks to answer. First, what are the factors influencing accessibility of ITNs? Second, what are the implications of access to ITNs on malaria morbidity? Provision of answers to this question will assist policy makers in designing adequate mechanisms for addressing malaria in Nigeria.

## 2. Materials and Methods

*Data and sampling procedures*

Survey-based 2008 Demographic and Health Survey (DHS) secondary data were used for this study. The women's questionnaire was used in addition to the household questionnaire. The primary sampling unit (PSU) referred to as a cluster for the 2008 NDHS is defined on the basis of EAs from the 2006 EA census frame. The 2008 DHS samples were selected using a stratified two-stage cluster design consisting of 888 clusters, 286 in the urban and 602 in the rural areas. A representative sample of 36,800 households was selected for the 2008 DHS survey, with a minimum target of 950 completed interviews

per state. In each state, the number of households was distributed proportionately among its urban and rural areas.

*Methods of Data Analysis*

*Descriptive Statistical Analysis*

They include: percentage, frequency distribution and mean. These tools was used to profile the socio-demographic characteristics of the households

*Logistic Regression Analysis*

The binary logistic regression model was employed to identify factors that influence access to ITNs. The binary logistic regression model is stated as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \text{--------,} + \beta_k X_k \qquad (1)$$

$Z_i$ is the binary variable that defines access to ITNs with value of 1 if yes and 0 otherwise. $ß_0$ is the intercept (constant), and $ß_1$, $ß_2$, to $ß_k$ are the regression coefficients of the predictor variables, $X_1$, $X_2$, and $X_k$ respectively. The logistic regression model is widely used to analyse data with dichotomous dependent variables. Hence it was considered a perfect model to use in this study because the dependent variable is dichotomous in nature. This method allows for maximum likelihood even when there is a single response to category, reduces the amount of computation required and directly estimates the probability of an event occurring, hence considered commendable for this study.

It was necessary to create dummy variables to use the selected demographic and enabling variables of this study in the logistic regression model. All variables that had several categories were regrouped to facilitate easy processing of the results. For each of the mentioned independent variables, one of the original categories was assigned the value of 0 and was taken to be the reference category in the analysis. This reference category was the one expected to have a minimal likelihood of the event. The probability of access to ITN were analysed in relation to the selected reference category. The rest of the categories were assigned dummy variables taking on the value of 1 for the respective categories and 0 for the reference category. The independent variables include number of household members, number of children 5 and under, sex of household head, age of household head, regions, North East (yes = 1, 0 otherwise), North West (yes = 1, 0 otherwise), South East (yes = 1, 0 otherwise), South South (yes = 1, 0 otherwise), South West (yes = 1, 0 otherwise), educational status of household head (years of education), read newspaper or magazine (1 for yes 0 otherwise), listen to radio (1 if yes, 0 otherwise), watch television (1 if yes, 0 otherwise), covered by health insurance (yes =1, 0 otherwise), occupation (agric employee=1, 0 otherwise), having pregnant women (yes= 1, 0 otherwise), type of cooking fuel (1 if wood, 0 otherwise), flooring materials 1 (1 if earth, 0 otherwise), flooring materials 2 (1 if sand, 0 otherwise), flooring materials 3 (1 if cement, 0 otherwise), flooring materials 4 (1 if carpet, 0 otherwise), number of rooms used for sleeping 1 (1 if one, 0 otherwise), number of rooms used for sleeping 2 (1 if two, 0 otherwise), sick people in the household (1 if yes, 0 otherwise), household access to electricity (1 if yes, 0 otherwise), marital status (1 if married, 0 otherwise), type of fire for cooking (1 if open fire, 0 otherwise).

Table 1: Socio-economic factors of the respondents

| Educational Level | Frequency | % |
|---|---|---|
| No education | 6,339 | 46.16 |
| Primary | 3,535 | 25.74 |
| Secondary | 2,868 | 20.89 |
| Higher | 990 | 7.21 |
| Male | 12,025 | 86.37 |
| Female | 1,898 | 13.63 |
| 15-30 | 2942 | 21.2 |
| 31-45 | 6015 | 43.4 |
| 46-60 | 3575 | 25.8 |
| 61-75 | 1124 | 8.1 |
| 76-90 | 198 | 1.4 |
| >90 | 14 | 0.1 |

Source: DHS, 2008

***Two stage Least Square Regression Model***

This econometric approach was used to determine the implication of access to ITNs on malaria morbidity. The model is specified as:

$$Y_i = ß_0 + ß_1 Z_i + ß_2 X_2 + ß_3 X_3 + \ldots, ß_K X_K + U_i \qquad (2)$$

$Y_i$ specifies malaria morbidity which was specified as 1 if yes and zero otherwise, $X_{1i,}$ ,.....,$X_{ki}$ denote household characteristics, $= ß0$ ,$ß1$..... ....$ß\ k$ are the parameter coefficients, *Ui* is the error term captures measurement error or omitted factors.

The above model is estimated using the Two Stage Least Squares (TSLS) in two stages. At the first-stage, regress Zi (access to ITNs) on the included exogenous variables and the instrumental variable (wealth index) using Logit regression. The predicted values are computed from this regression. Call these $\hat{x}$. Second-stage involves regression of $Y_i$ on the predicted values of the endogenous variable $Z_i$ and the included exogenous variable using logistic regression. The instrument used satisfies the necessary and sufficient condition. The necessary condition implies that the instrument must correlate with the endogenous variable in the equation and sufficient condition that the instrument must not correlate with the endogenous variable in the

structural equation. Pair-wise correlation was used to test for the condition of the instrument.

## 3. Results and Discussions

*Socio Economic and Demographic Characteristics of Households*

This study presents information on selected socio-economic and demographic characteristics of households in rural Nigeria. Table 1 shows that 41.16% household head in rural Nigeria have no education, 25.74% had primary education, 20.89% had secondary education, while just minority had higher education (7.21%). The table also indicates 86.37% of rural households in Nigeria were headed by men, while 13.63% were headed by women. Also, age group 31-45 years had the highest percentage of 43.4%, while age group for the greater than 90 years had the lowest percentage. The average age of the household head in rural Nigeria was 43 years.

*Factors Influencing Access to ITNs*

Table 2: Logistic regression result of factors influencing access to ITN

| Variables | Coefficients | Standard error | Marginal effects |
|---|---|---|---|
| Constant | -3.230282 | 0.3058944 | |
| Pregnancy | 0.1405137* | 0.0805342 | 0.0109754* |
| Household size | 0.0356648* | 0.0145457 | 0.0026736* |
| No of children 5 & under | 0.0767332** | 0.0323422 | 0.0057522** |
| North East region | 0.2647132** | 0.105003 | 0.0211686** |
| North West region | 0.0469051 | 0.1048574 | 0.0035482 |
| South East region | 0.4517435** | 0.1194123 | 0.00396181** |
| South south region | 0.5352944*** | 0.1048184 | 0.0472135*** |
| South west region | -0.1434803 | 0.1325832 | -0.010252 |
| Sex of hh | -0.1602343* | 0.1005032 | -0.0131127* |
| Age of hh | -0.009312*** | 0.0031003 | -0.006981*** |
| Pry edu | 0.4498552*** | 0.856677 | 0.0370663*** |
| Sec. Edu | 0.6145683*** | 0.0939357 | 0.537659*** |
| Higher edu | 0.9786426*** | 0.1159372 | 0.104106*** |
| Listen to radio | 0.1847302*** | 0.0717711 | 0.013727*** |
| Read newspaper | 0.219324** | 0.096524 | 0.0177437** |
| Watch tv | 0.0955269 | 0.082737 | 0.0072875 |
| Health insurance | -0.0716642 | 0.2727809 | -0.0052161 |
| Occupation | -0.2283824*** | 0.0697977 | -0.0173097*** |
| Wood cooking fuel | -0.1808867 | 0.1346643 | -0.0143999 |
| Earth flooring material | 0.1134846 | 0.2114385 | 0.0084679 |
| Cement flooring material | 0.2940763 | 0.2086683 | 0.022947 |
| Carpet flooring material | 0.2243488 | 0.2233116 | 0.0182128 |
| Open fire | 0.3485725** | 0.1547794 | 0.0231109** |
| Marital status | 0.2191825* | 0.1305854 | 0.0152198* |
| Sick person in household | 0.0762923 | 0.1528991 | 0.0058902 |
| Electricity | 0.1705894** | 0.0746421 | 0.0132285** |
| One room for sleeping | -0.242436*** | 0.0902644 | -0.174081*** |
| Two rooms for sleeping | -0.1037864 | 0.765927 | -0.0076705 |
| Log likelihood = -4029.6737<br>Number of obs = 13626<br>LR chi2(28) = 485.44<br>Prob > chi2 = 0.0000<br>Psedu R 2 =0.0568 | | | |

Source: DHS, 2008

***, ** and * represent significance at 1%, 5% and 10% probability levels respectively

The logistic regression result of factors influencing access to ITN is shown in table 2. An additional insight was also provided by analysing the marginal effects which was calculated as the partial derivatives of the non linear probability function evaluated at each variable sample mean.

Most of the explanatory variables were discovered to influence access to ITN. Pregnant women in the household, household size, north east,

south east, and south south regions, number of children 5 years and under, age of household head, sex of household head, educational status, listening to radio, read newspaper, occupation, electricity, one room for sleeping in the household and marital status were found to be statistically significant ($p<0.10$). Other studies have also reported the number of very young children in the household as a determinant of bed net ownership (Tanner *et al*; 1998; Yeneneh *et al*; 1993).

Virginia *et al* (2007) also reported age, household size, occupation, ethnicity and education as a determinant of ITN ownership. Nuwaha (2001) also found gender to be a significant factor. It has also been demonstrated that when women are pregnant, they fall into a high risk malaria group, and therefore they receive greater exposure to health services and gain a higher level of awareness of the disease and ways of preventing it (Rashed *et al*., 1999).

Variables with negative value imply a negative relationship between the explanatory variables and dependent variable. For instance, age of household head was negative and significant which implies that as age increases the probability of household access to ITN decreases. South West region, sex of household head, occupation, using wood as cooking fuel and age of household head have negative influence on the probability of access to ITNs.

Variables with positive coefficient imply a positive relationship of the explanatory variables and dependent variable. The coefficient of number of children 5 years and under is positive which implies that as the number increases, probability of access to ITN also increases. The result of marginal effects showed that 1% increase in pregnant women in the household, number of children 5 years and under, household size will increase the probability of access to ITN by 1%, 0.6%, 0.3% respectively. However, a unit increase in age of household head will decrease the probability of access to ITN by 0.7%.

Table 3: Two Stage Least Squares Regression results of implication of factors influencing access to ITN on Malaria morbidity

| Variables | 2SLS | OLS |
|---|---|---|
| Constant | 0.27145 | 0.27308 |
| | (0.0976) | (0.0975) |
| ITN | 0.09310 | 0.00913 |
| | (0.0253) | (0.0339) |
| Pregnancy | 0.08669*** | 0.08805*** |
| | (0.0277) | (0.0274) |
| Household size | -0.05217*** | -0.05186*** |
| | (0.0050) | (0.0049) |
| No of children 5 & under | 0.12536*** | 0.12609*** |
| | (0.0113) | (0.0110) |
| North East region | 0.11901*** | 0.12134*** |
| | (0.0334) | (0.3249) |
| North West region | 0.02718 | 0.02790 |
| | (0.0317) | (0.0316) |
| South East region | 0.18802*** | 0.19315*** |
| | (0.0459) | (0.0428) |
| South south region | 0.02175 | 0.02770 |
| | (0.0422) | (0.0373) |
| South west region | -0.08206** | -0.08345*** |
| | (0.0412) | (0.0409) |
| Sex of hh | 0.180096*** | 0.17849*** |
| | (0.0355) | (0.0351) |
| Age of hh | -0.00655*** | -0.00662*** |
| | (0.00097) | (0.0009) |
| Pry edu | -0.05660** | -0.05348** |
| | (0.02828) | (0.0263) |
| Sec. Edu | -0.05522 | -0.05029 |
| | (0.03523) | (0.0307) |
| Higher edu | -0.11476** | -0.10338** |
| | (0.05894) | (0.0454) |

| | | |
|---|---|---|
| Listen to radio | 0.04459** | 0.04604** |
| | (0.02276) | (0.0222) |
| Read newspaper | 0.05508 | 0.05853 |
| | (0.04111) | (0.0395) |
| Watch tv | 0.04177 | 0.04300 |
| | (0.02923) | (0.0289) |
| Health insurance | 0.01018 | 0.00922 |
| | (0.1152) | (0.1151) |
| Occupation | -0.12271*** | -0.12467*** |
| | (0.0234) | (0.0225) |
| Wood cooking fuel | 0.02081 | 0.01919 |
| | (0.0476) | (0.0473) |
| Earth flooring material | 0.0629 | 0.06398 |
| | (0.0632) | (0.0631) |
| Cement flooring material | 0.08110 | 0.08379 |
| | (0.0643) | (0.0636) |
| Carpet flooring material | 0.07588 | 0.07797 |
| | (0.0725) | (0.0722) |
| Open fire | -0.04316 | -0.03936 |
| | (0.0573) | (0.0559) |
| Marital status | -0.10014** | -0.09775** |
| | (0.0433) | (0.0426) |
| Electricity | -0.03892 | -0.03705 |
| | (0.0508) | (0.0295) |
| One room for sleeping | 0.12781*** | 0.12559*** |
| | (0.0272) | (0.0251) |
| Two rooms for sleeping | -0.02716 | -0.02812 |
| | (0.0304) | (0.0975) |
| No of obs =13626 | | |
| F(28, 13597)=22.74 | | |
| Prob>F=0.000 | | |
| R-squared=0.0447 | | |
| Adj R-squared=0.0428 | | |
| RootMSE=1.1389 | | |

Source : DHS, 2008 ***, ** and * represent significance at 1%, 5% and 10% probability levels respectively (Standard errors are in parentheses)

*Access to ITNs and Malaria Morbidity*

Table 3 presents the result of the implication of factors influencing access to ITNs on malaria morbidity under two different estimation procedures: 2SLS and OLS, for comparison. Hausman test was carried out and revealed that the 2SLS is not significantly different from OLS. Variables that significantly has implication on malaria morbidity are pregnant women, household size, number of children 5 years and under, sex of household head, age of household head, occupation, one room for sleeping in the household, north east, south east and South west regions, marital status, listening to radio and education.

However, reading newspaper, watching television, covered by health insurance, access to ITN, flooring materials, type of cooking fuel, household access to electricity, having more than two rooms for sleeping, and south south and northwest region were found to be insignificant and this implies that they do not have implication on malaria morbidity.

Insignificant relationship between access to ITNs and malaria morbidity could indicate low coverage of ITNs. It could also imply that household ownership of ITNs may not necessarily imply their usage.

Variables with negative value imply a negative relationship between the explanatory variables and dependent variable. For instance, a negative coefficient of household size means that the higher the number of household members, the lower the malaria morbidity. Variables with positive coefficient imply a positive relationship of the explanatory variables and dependent variable. For instance, the higher the number of children 5 years and under, the higher the malaria morbidity. Also, increasing the number of pregnant women in the

household increases the probability of malaria morbidity. These results can be explained from the fact that children are highly susceptible to malaria, having got little immunity against disease infections. Similarly, when women are pregnant, their immunity to malaria seems to reduce. Therefore, the results are in line with a priori expectations.

## 4. Conclusion

Most malaria control programs undertake a range of activities designed to promote access to ITNs. This is justified on the basis that malaria is on the increase and the demonstrated effectiveness of ITN use in reducing malaria but the success of these interventions depends largely on the extent to which factors that influence access are addressed. In this study, we reported factors that influence access to ITN and its implication on malaria morbidity. In terms of malaria control policy, the role of information campaign in promoting access to ITNs should not be underestimated. The result of this study indicates that listening to radio and reading newspaper will increase the probability of access to ITN. The reason is that information is considered a prerequisite for promoting good interactions between the health system, individuals and communities. It empowers individuals to make well informed decisions about health services use. To ensure utilization of ITNs by households, there should be massive education campaigns that should address how to properly use ITNs and their importance in malaria prevention.

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