Research and Reports in Tropical Medicine

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ORIGINAL RESEARCH

# Household bed net ownership and use among under-5 children in Nigeria



This article was published in the following Dove Press journal:
Research and Reports in Tropical Medicine
24 July 2013
Number of times this article has been viewed

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**Background:** Malaria remains the leading cause of morbidity and mortality in sub-Saharan Africa, with children under 5 years accounting for 86% of all malaria deaths. For effective control of malaria, WHO recommends rapid diagnosis and effective treatment, insecticide-treated bed nets, and indoor residual spraying. The use of insecticide-treated bed nets has been shown to be the most cost-effective strategy in preventing this infection. However, despite the Roll Back Malaria subsidized and free bed net distribution initiatives in some Africa countries, bed net uptake and usage still remains low in many households.

**Aim:** This study aimed to investigate household characteristics and child factors that determine bed net ownership and use amongst under-5 children and the effect of its usage on malaria parasitemia in under-5 children in Nigeria.

**Methods:** Data from a nationally representative sample of 5895 households was obtained from the 36 states and the Federal Capital Territory in the 2010 Nigeria demographic and health survey, with a minimum of 67 households enrolled per state. Appropriate statistical tools were used to identify the characteristics of households that owned a bed net and to examine the association between the households and child-level factors that predict the use of bed net and malaria prevalence among under-5 children within these households.

**Results:** The rate of households bed net ownership in Nigeria is about 45.5%. About 48.5% of under-5 children in 33.9% of households surveyed, use a bed net during sleep. There was a strong correlation between households ownership and child sleeping under a bed net ($r = 0.706$, $P < 0.001$). Acquisition of these bed nets at no cost significantly determined ownership ($P < 0.001$) but not usage ($P = 0.450$). Ownership of a bed net was significantly higher in households in rural areas ($P = 0.001$), poorer households ($P = 0.001$), households with an under-5 child ($P = 0.001$), households whose heads were male ($P = 0.001$), and of lower educational attainment ($P = 0.010$). There was a greater likelihood of under-5 children sleeping under a bed net in households with two or more under-5 children (odds ratio [OR] 1.26; CI: 1.05−1.66), two or more bed nets (OR 2.03; CI: 1.56−2.66), and in households whose heads were younger ([OR 2.79; CI: 1.65–4.70] for household heads younger than 29 years and [OR 1.6; CI: 1.17–2.19] for those 30-49 years of age), female (OR 1.61; CI: 1.00−2.61), and poorer (OR 1.77; CI: 1.03−3.04), and less likely in households with more than three other (aside from the under-5 children) household members ([OR 0.23; CI: 0.08-0.69] for household with 4–6 family members and [OR 0.20; CI: 0.07–0.61] for households with 7 or more family members). Malaria parasitemia in under-5 children was higher in: households without a bed net (41.9% versus [vs] 34.2%) ($P = 0.016$), in children who did not sleep under a bed net (39.7% vs 35.0%) ($P = 0.292$), in poor households compared to middle and rich households (50.5% vs 44.9% vs 25.9%; $P = 0.001$), and households in rural settlements (42.6% vs 19.6%) ($P = 0.001$).

**Conclusion:** Bed net ownership in households in Nigeria is poor and does not translate to usage. Governments and organizations should not just distribute these nets free of charge to households, but also follow up with regular visits and provision of household education to

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http://dx.doi.org/10.2147/RRTM.S45586

ensure consistent and correct use, especially amongst under-5 children and pregnant women, who are the most vulnerable to infections and complications from malaria.

**Keywords:** household, bed nets, under-5 children, Nigeria

## Introduction

According to the World Malaria Report 2011, there were about 216 million cases of malaria globally (with an uncertainty range of 149 million to 274 million) and an estimated 655,000 deaths in 2010 (with an uncertainty range of 537,000 to 907,000).[1] About 174 million (80.5%) of these cases and 596,000 (90.1%) of these deaths occurred in Africa, and 86% of the death burden is borne by children under 5 years of age.[2] Six countries account for 60% (390,000) of the global burden of deaths caused by malaria − Nigeria, Democratic Republic of the Congo, Burkina Faso, Mozambique, Ivory Coast, and Mali. In Africa, malaria is responsible for an annual loss of 35 million future life years from disability and prematurity.[3] The malaria infection accounts for at least 1.3% reduction in Africa's economic growth annually, with approximately US$ 12 billion annual losses both as a direct and indirect cost of disease.[2] The United Nations (UN) Inter-agency for Child Mortality in 2010 summarized the burden of malaria disease borne by Africa, and this is shown in Table 1.

For effective malaria control the World Health Organization (WHO) Global Malaria Programme recommends three primary intervention strategies: diagnosis of malaria cases and treatment with effective medicines; distribution of insecticide-treated nets and specifically, long-lasting insecticidal nets, especially for under-5 children and pregnant mothers; and indoor residual spraying to reduce and eliminate malaria transmission.[5] Analysis of the cost-effectiveness of these interventions shows that use of treated nets is most practical,[6] and most cost-effective.[2] It was estimated that it costs US$ 1.39 per person per year for use of a long-acting insecticide-treated net compared with US$ 1.4−1.9 per adult and US$ 0.5−0.9 per child for diagnosis and treatment of each episode (usually 3−6 episodes per year) of malaria in Africa.[2]

**Table 1** Estimated malaria burden and progress report in the seven regions of the world in 2010

| Region | % Malaria | | % Reduction since 2000 | |
|---|---|---|---|---|
| | Morbidity | Mortality | Morbidity | Mortality |
| Africa | 80.5 | 90.10 | 1 | 13 |
| America | 0.4 | 0.15 | 56 | 48 |
| Eastern Mediterranean | 4.6 | 2.29 | 0 | 12 |
| Europe | 0.0001 | 0.00 | 99 | 100 |
| Southeast Asia | 12.9 | 5.80 | 15 | 17 |
| West Pacific | 0.9 | 0.76 | 42 | 37 |

**Note:** Data from[4].

The efficacy of insecticide-treated bed nets is well documented in several studies[7–10] in Africa. Recent analysis showed that 489,200 malaria deaths were averted through insecticide-treated net coverage between 2000 and 2008, with almost half averted since 2006. It is estimated that six lives could be saved for every 1,000 children protected under bed nets, translating to approximately 336,000 malaria deaths averted if every child slept under insecticide-treated nets, per year. In a nationwide campaign done in Kenya by the National Malaria Control Center, which distributed over six million bed nets between 2007−2010 to over 1 million households, which resulted in 73% of households owning one or more bed nets and 52% of under-5 children in rural areas sleeping under a bed net, there was a reduction in prevalence of malaria parasitemia from 22%, in 2006, to 16%, in 2009.[11]

With the aid of many international organizations and the commitment by the government of many African countries to reducing the burden of malaria to its barest minimum by 2015, million of dollars worth of Artemisinin-based drugs and mosquito nets have been distributed free of charge in Nigeria[12] and many other African countries. However the use of these bed nets by household members and vulnerable groups has been far from optimal. Different studies[13–15] in different states in Nigeria have looked into the determinants of household ownership and usage of bed nets in Nigeria and showed ownership and use by children to be between 42.6%−68.1% and 27.5%−37.25%, respectively. However, none has covered the 36 states of the country. This study intends to describe the household variables that determine bed net ownership and factors affecting their usage for under-5 children in Nigeria. With one in every six Africans being a Nigerian, the findings of this study will help enhance policies targeted at bed net distribution, ownership, and usage amongst the most vulnerable group (under-5 children and pregnant women) in particular and household members in general.

## Methods

### Study area

Nigeria is in the West African subregion, lying between Niger in the north, Chad to the northeast, Cameroon in the east, and Benin to the west (Figure 1). The 2006 population and housing

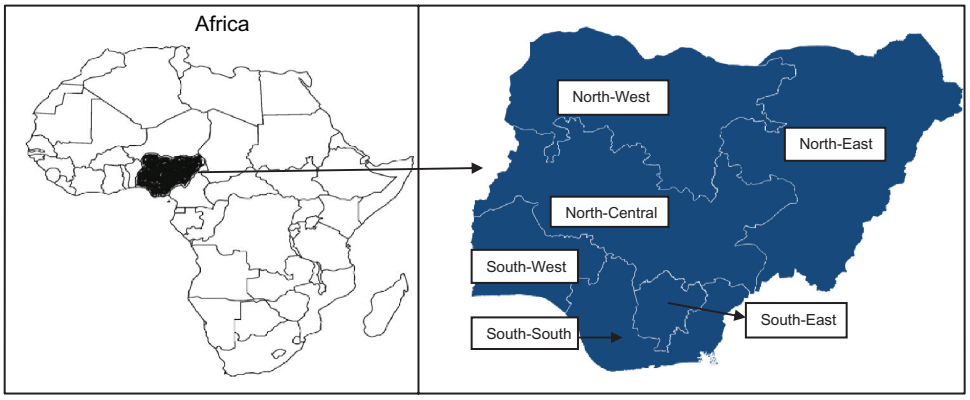


**Figure 1** Six regions of Nigeria and its location within Africa.

census puts Nigeria's population at 140,431,790, making it the most populous nation in Africa and 14th in the world.[16] Presently, Nigeria is made up of 36 states and a Federal Capital Territory, grouped into six geopolitical regions: North Central, North East, North West, South East, South West, and South South. There are 774 constitutionally recognized local governments and about 374 identifiable ethnic groups.[17] This survey was conducted in all states (including the Federal Capital Territory) within the six regions of Nigeria.

## Study design and sample selection

This is a cross-sectional, descriptive-analytical study. Data on bed net ownership and its use by under-5 children within households in Nigeria were collected as part of the Nigeria Demographic and Health Survey (DHS). This study specifically used data from the 2010 edition of the Malaria Indicator Survey, which is a nationally representative probability sample based on the sampling frame of the 2006 Population and Housing Census of the Federal Republic of Nigeria, conducted by the National Population Commission.[18]

Data were collected using a stratified two-stage cluster sampling design consisting of 240 clusters, with a minimum of 26 clusters per region in 83 urban and 157 rural areas. In all, a nationally representative sample of 6,197 households was selected for the 2010 DHS survey, with 5,986 households eligible for interview.[18] A minimum of 67 households were interviewed per state (see Table 2). In the second stage of selection, sampling of individuals to be interviewed within each household was performed according to the list of enumeration areas developed from the 2006 Population Census sampling frame. Of the 5,895 households finally selected from the 5,986 eligible households, 5,146 under-5 children were identified. The household response rate was 99%.[18]

**Table 2** The region, state, and location of households surveyed in Nigeria

| Region | States | Households surveyed | Urban | Rural |
|---|---|---|---|---|
| | | N | N (%) | N (%) |
| North Central | Abuja (FCT) | 67 | 44 (65.7) | 23 (34.3) |
| | Benue | 200 | 22 (11.0) | 178 (89.0) |
| | Kogi | 169 | 77 (45.8) | 91 (54.2) |
| | Kwara | 130 | 52 (40.0) | 78 (60.0) |
| | Nasawara | 101 | 25 (24.8) | 76 (75.2) |
| | Niger | 181 | 25 (13.8) | 156 (86.2) |
| | Plateau | 150 | 73 (48.7) | 77 (51.3) |
| North East | Adamawa | 170 | 46 (27.1) | 124 (72.9) |
| | Bauchi | 214 | 49 (22.9) | 165 (77.1) |
| | Borno | 218 | 69 (31.7) | 149 (68.3) |
| | Gombe | 129 | 26 (20.2) | 103 (79.8) |
| | Taraba | 115 | 24 (20.9) | 91 (79.1) |
| | Yobe | 123 | 23 (18.7) | 100 (81.3) |
| North West | Jigawa | 100 | 0 (0.0) | 100 (100) |
| | Kaduna | 206 | 77 (37.4) | 129 (62.6) |
| | Kano | 253 | 48 (19.0) | 205 (81.0) |
| | Katsina | 182 | 52 (28.6) | 130 (71.4) |
| | Kebbi | 76 | 0 (0.0) | 76 (100) |
| | Sokoto | 119 | 22 (18.5) | 97 (81.5) |
| | Zamfara | 73 | 0 (0.0) | 73 (100) |
| South East | Abia | 179 | 77 (43.0) | 102 (57.0) |
| | Anambra | 216 | 169 (78.2) | 47 (21.8) |
| | Ebonyi | 149 | 24 (16.1) | 125 (83.9) |
| | Enugu | 201 | 100 (49.8) | 101 (50.2) |
| | Imo | 252 | 25 (9.9) | 227 (90.0) |
| South South | Akwa ibom | 194 | 24 (12.4) | 170 (87.6) |
| | Bayelsa | 104 | 26 (25.0) | 78 (75.0) |
| | Cross river | 129 | 25 (19.4) | 104 (80.6) |
| | Delta | 198 | 72 (36.4) | 126 (63.6) |
| | Edo | 148 | 51 (34.5) | 97 (65.5) |
| | Rivers | 234 | 78 (33.3) | 156 (66.7) |
| South West | Ekiti | 96 | 46 (47.9) | 50 (52.1) |
| | Lagos | 275 | 254 (92.4) | 21 (7.6) |
| | Ogun | 86 | 18 (20.9) | 68 (79.1) |
| | Ondo | 129 | 51 (39.5) | 78 (60.5) |
| | Osun | 125 | 73 (58.4) | 52 (41.6) |
| | Oyo | 205 | 77 (37.6) | 128 (62.4) |
| Total | 37 | 5895 | 1944 (33.0) | 3951 (67) |

**Abbreviation:** FCT, Federal Capital Territory.

Data collection was done by 86 people trained as field staff, supervisors/editors, quality control interviewers, female and male interviewers, reserve interviewers, nurses, and laboratory technicians. A pretest training involving 20 persons was done in August 2010 in Kaduna, northern Nigeria. The main training for the field staff who conducted the state interviews was done during a 3-month period in October–December 2010. The training consisted of instruction regarding interviewing techniques and field procedures, detailed review of the items on the questionnaire, a mock interview between participants in the classroom, and practice interviews with real respondents in an area outside the DHS sample point.[18] Information collected included, but was not limited to, in-depth demographic and socioeconomic information about the household, medical care, use of antenatal and postnatal services, child immunizations and anthropometric details of children in the household, knowledge of malaria prevention, and measure(s) used to prevent malaria, such as ownership and use of bed nets, insecticide spray, fumigation and drug treatments, etc. A blood smear for malaria parasite was also done on some of the children, where consent was given.[18]

## Outcome variables

The outcome variables were the proportion of households that owned a bed net, the proportion of under-5 children sleeping under a mosquito bed net, and the prevalence of malaria in under-5 children within these households.

## Predictor variables

### Child-level factors

Four child-level variables of interest were examined: (1) sex, classified as: male or female; (2) birth rank, created and classified as: first born, second born to third born, fourth to sixth born, or seventh or later born; (3) age, classified as: less than 24-months old, or 24–59 months; and (4) number of under-5 children in the family, classified as: one and two or more.

### Household-level factors

The household-level variables were: (1) highest educational level of the household head, defined as the highest attainment of education of the household head and categorized as: none, primary education (six years of basic education), or secondary and higher (over six years of postprimary education and/or college, polytechnic, or university); (2) age of the household head, categorized as less than 29 years, 30–49 years, or 50 years and older; (3) sex of the household head, categorized as: male or female; (4) household wealth index, defined as the financial and economic status of the household and categorized as poor, middle class, or rich class; (5) number of bed nets in the household, defined as the number of treated or non-treated bed nets the household had during the period of the survey and categorized as only one vs two or more; (6) number of people living in the household, grouped into one to three, four to six, or seven or more; (7) household dwelling sprayed in the last year, defined as the environment where the household residence is located was fumigated in the 1-year period preceding the survey, and was categorized as yes or no; (8) how households acquired bed nets, classified into "paid for" for households who paid for their bed nets, and "free of charge" for those who acquired their bed nets at no cost; (9) amount the household spent on bed net(s) in the last year, categorized as: less than US$ 4, US$ 4–10, or more than US$ 10; (10) household ownership of electricity in the households and/or generators sets and/or air-conditioners and/or fans, categorized as: yes or no; (11) location of the household, categorized as: urban or rural; and (12) region of residence of the household, categorized according to the six geopolitical zones in Nigeria, as: North Central, North East, North West, South East, South South, and South West.

## Ethical considerations

The survey procedure and instruments for the Nigeria DHS received ethical approval from the Ethics Committee of the Opinion Research Corporation (ORC) Macro International Inc, Washington, DC, USA and by the National Ethics Committee in the Federal Ministry of Health of Nigeria. Informed consent was obtained from all participants prior to participation in the survey, and the collection of information was confidential. This study is based on the analysis of secondary data, with all participant identifiers removed. Ethical permission for use of the data in the present study was obtained from ORC Macro Inc.[18]

## Analysis

The PASW (Predictive Analytics Software) version 20.0 statistical package (IBM Corp, Armonk, NY, USA) was used for data analysis. The Pearson chi-square ($\chi^2$) test was used to study the differences in proportion between household/child level variables, household ownership of a bed net, and proportion of under-5 children sleeping under bed nets within these households. Association between the outcome and predictor variable was assessed using logistic regression carried out in two models. In model 1, child-level factors were fitted separately to estimate the baseline association between child level variables and the likelihood of an under-5 child using a bed net. Household-level factors

were thereafter controlled for in model 2. This was done to see how these households factors (level-2 variables) modified the likelihood of an under-5 child sleeping under a bed net. The largest category in each predictor variable was used as the reference category. Results were presented in percentages, odds ratios, and 95% confidence intervals where appropriate. For all statistical tests performed, it was ensured that the assumptions for carrying out these specific tests were met. Statistical significance was set at $P$-value $< 0.05$.

# Results

## Households' characteristics

A total of 5,895 households were successfully enrolled for this study, with a minimum of 67 per state. The mean age of the household heads was 45.59 ± 15.84, years with a maximum and minimum age of 98 and 15 years respectively. The mean number of rooms per household was 3.67 ± 2.62 rooms, with a maximum of 28 rooms and minimum of one room. However the number of sleeping rooms ranged from 22 to one, with a mean of 2.49 ± 1.74 per household. On the average, there were 0.88 ± 0.034 bed nets per household, with maximum number seven and a minimum number of zero bed nets owned by a household (Table 3). The total number of people living in a household varied from one to 28 people, with a mean value of 5.18 ± 3.16 per household. Table 4 shows a summary of the households employed in the study. Only 2,673 (45.5%) of households owned a bed net. About 1,944 (33.0%) were located in an urban area and 3,951 (67.0%) in rural area, with about 38% (37.9%) and 49.3%, respectively owning a bed net ($P = 0.001$). The majority (83.1%) of the households had a male as its household head, and 47.5% of these had a bed net compared with the 996 (16.9%) of households headed by a female, of which 35.8% had a bed net ($P = 0.001$). About 38% (38.3%), 47.1%, and 14.6% of the households head were headed by people who were 50 years and older, 30−49, and 29 years and younger, respectively. For those households headed by people 50 years and above, 40.7% and 59.3% owned and did not own a bed net, respectively, while 50% of households headed by people 30−49 years of age, and 43.9% of households headed by people 29 years and below, owned a bed net ($P = 0.001$).

Households in the poor wealth category, which made up 33.4% of households surveyed, had the highest rate (52.0%) of bed net ownership. This was followed by households in the middle wealth category (19.4%) with an ownership rate of 51.1%, while the lowest rate of bed net ownership (38.6%) was in the rich wealth households that made up 47.2% of all households surveyed ($P < 0.05$). Households whose head had no form of education accounted for 38.5% of those surveyed, whereas those whose head had only primary education accounted for 21.9%, and households whose heads had secondary and higher education attainment accounted for 38.6%. The proportion of bed net ownership was, surprisingly, highest (51.7%) in households whose head had no form of education compared with 42.9% in those with only primary education and 40.6% in those with higher educational attainment ($P < 0.05$).

Table 5 shows the characteristics of households that owned at least one bed net. About 1,406 (95.6%) of the 1,475 owned bed nets were treated, while 64 (4.4%) were untreated. In total, 321 (22.8%) and 1,085 (77.2%) of the treated bed nets compared with 36 (56.3%) and 28 (43.8%) of the untreated nets were paid for and acquired free of charge, respectively ($P < 0.05$). In total, 553 households (20.9%) paid for their nets, while 2,090 (79.1%) households acquired their nets at no cost. In households that paid for their bed nets 157 (28.6%) had spent less than US$ 4 in the previous 1 year on bed nets, while 351 (64.1%) and 40 (7.3%) had spent US$ 4−10 and more than US$ 10, respectively in the last 1 year. Sources of bed net acquisition included: net distribution campaigns, 1,447 (55.3%); health care institutions (24.7%); markets (19.0%); pharmacies or drug sale outlets

**Table 3** Descriptive statistics of households

| Variable (N = 5,895) | Mean ± standard deviation | Maximum | Minimum | Range | Standard error |
|---|---|---|---|---|---|
| Number of households (per state) | 159.32 ± 54.37 | 275 | 67 | 208 | 9.062 |
| Age of household head | 45.59 ± 15.84 | 98 | 15 | 83 | 0.207 |
| Number of rooms in household | 3.67 ± 2.62 | 28 | 1 | 27 | 0.340 |
| Number of rooms used for sleeping | 2.49 ± 1.74 | 22 | 1 | 21 | 0.230 |
| Number of bed nets | 0.88 ± 0.03 | 7 | 0 | 7 | 0.160 |
| Total number of household members | 5.18 ± 3.16 | 28 | 1 | 27 | 0.410 |
| Number of under-5 children | 0.87 ± 0.03 | 11 | 0 | 11 | 0.016 |
| Age of child (months) | 37.95 ± 14.77 | 59 | 6 | 53 | 0.257 |

**Table 4** Characteristics of households and bed net ownership

| Households variables | N (%) | % household owns a bed net | | $\chi^2(p)$ |
|---|---|---|---|---|
| | | No | Yes | |
| **Age of household head (years)** | | | | |
| Less than 29 | 861 (14.6) | 56.1 | 43.9 | 0.001 |
| 30–49 | 2775 (47.1) | 50.0 | 50.0 | |
| 50 or more | 2258 (38.3) | 59.3 | 40.7 | |
| **Sex of household head** | | | | |
| Male | 4899 (83.1) | 52.5 | 47.5 | 0.001 |
| Female | 996 (16.9) | 64.2 | 35.8 | |
| **Educational level of household head** | | | | |
| None | 2269 (38.5) | 48.3 | 51.7 | 0.010 |
| Primary | 1291 (21.9) | 57.1 | 42.9 | |
| Secondary or higher | 2275 (38.6) | 59.4 | 40.6 | |
| **Wealth index of household** | | | | |
| Poor | 1971 (33.4) | 48.0 | 52.0 | 0.001 |
| Middle | 1143 (19.4) | 48.9 | 51.1 | |
| Rich | 2781 (47.2) | 61.4 | 38.6 | |
| **Number of sleeping rooms in household** | | | | |
| 1 | 1798 (30.5) | 64.3 | 35.7 | 0.001 |
| 2 | 1949 (33.1) | 51.8 | 48.2 | |
| 3 | 1018 (17.3) | 49.6 | 50.4 | |
| 4 or more | 1115 (18.9) | 47.6 | 52.4 | |
| **Number of persons living in household** | | | | |
| 1–3 | 1915 (32.5) | 64.4 | 35.6 | 0.001 |
| 4–6 | 2347 (39.8) | 53.2 | 46.8 | |
| 7 or more | 1633 (27.7) | 44.7 | 55.3 | |
| **Household surroundings sprayed in the last 1 year** | | | | |
| No | 5802 (98.4) | 54.8 | 45.2 | 0.001 |
| Yes | 57 (1.6) | 28.1 | 71.9 | |
| **Household has children under-5** | | | | |
| No | 2346 (39.8) | 64.2 | 35.8 | 0.001 |
| Yes | 3549 (60.2) | 48.1 | 59.1 | |
| **Household has electricity** | | | | |
| No | 2811 (48.0) | 47.8 | 52.2 | 0.001 |
| Yes | 3051 (52.0) | 60.6 | 39.4 | |
| **Household has a generator set** | | | | |
| No | 4438 (75.8) | 53.8 | 46.2 | 0.114 |
| Yes | 1418 (24.1) | 56.2 | 43.8 | |
| **Household has a fan** | | | | |
| No | 3450 (58.8) | 50.5 | 49.5 | 0.001 |
| Yes | 2415 (41.2) | 60.0 | 40.0 | |
| **Household has an air conditioner** | | | | |
| No | 5750 (98.3) | 54.5 | 45.5 | 0.702 |
| Yes | 100 (1.7) | 52.5 | 47.5 | |
| **Household location** | | | | |
| Urban | 1944 (33.0) | 62.1 | 37.9 | 0.001 |
| Rural | 3951 (67.0) | 50.7 | 49.3 | |
| **Region of household** | | | | |
| North Central | 997 (16.9) | 64.7 | 35.3 | 0.001 |
| North East | 969 (16.4) | 32.5 | 67.5 | |
| North West | 1009 (17.1) | 36.0 | 64.0 | |
| South East | 997 (16.9) | 64.8 | 35.2 | |
| South West | 1007 (17.1) | 54.5 | 45.5 | |
| South South | 916 (15.5) | 75.9 | 24.1 | |

**Table 5** Characteristics of household that owns at least one bed net

| Variables | Proportion | Percentage |
|---|---|---|
| | n | (%) |
| **Number of bed nets in household** | | |
| 1 | 1045 | 39.1 |
| 2 or more | 1628 | 60.9 |
| **Type of bed net** | | |
| Treated | 1406 | 95.6 |
| Nontreated | 64 | 4.4 |
| **How bed net was acquired** | | |
| Paid for | 553 | 20.9 |
| Free of charge | 2090 | 79.1 |
| **Amount spent on bed net in the last 1 year (US$)** | | |
| Less than 4 | 157 | 28.6 |
| 4–10 | 351 | 64.1 |
| More than 10 | 40 | 7.3 |
| **Number of people that sleep under one bed net** | | |
| 1 | 943 | 45.1 |
| 2 | 619 | 29.6 |
| 3 or more | 529 | 25.3 |
| **Where bed net was obtained** | | |
| Net distribution campaign | 1447 | 55.3 |
| Health care institution | 646 | 24.7 |
| Pharmacy/drug store | 17 | 0.6 |
| Church/mosque | 10 | 0.4 |
| Market | 497 | 19.0 |
| **Bed net hanging over bed** | | |
| No | 511 | 19.7 |
| Yes | 2088 | 80.3 |

(0.6%); and churches/mosques (0.4%). About 1,045 (39.1%) of the households had only one bed net, while 1,628 (60.9%) had two or more bed nets. In 943 (45.1%) of the households, there was only one person per bed net, while there were two persons per bed net in 29.6% of the households, and in 529 (25.3%) of the households, there were more than three people sleeping under one bed net. Finally a net was reported or observed hanging over the bed in 2,088 (80.3%) of households and not hanging over the bed in 19.7% of households.

## Child characteristics

About 3,549 (60.2%) percent of the 5,895 households surveyed had an under-5 child. There were 5,146 under-5 children nested within these 3,549 households, giving an average of 1.45 under-5 children per household, with a mean age of 37.95 ± 14.77 months, a minimum and maximum age of 6 and 59 months, and an age range of 53 months. There was high correlation between a child sleeping under a bed net and household ownership of bed nets ($r = 0.706$; $P = 0.001$) and

number of bed nets in the household ($r = 0.702$; $P = 0.001$). Within these households, a majority (51.0%) had two or more under-5 children, while 49.0% of the households had only one under-5 child. About 1,837 (51.8%) of households with an under-5 child owned a bed net compared with 836 (35.8%) households without an under-5 child that owned a bed net ($P < 0.05$). Among the households that had an under-5 child and owned a bed net, only 1,202 (67.8%) of these households used the bed net for the child, while in 576 (32.2%) of the 1,837 households, the child/children did not use or sleep under these bed nets.

The reasons for a child not sleeping under the bed net in these households included, but was not limited to: no mosquitoes inside the room (19.7%), room too hot (27.7%), bed net usually difficult to hang (25.4%), don't like the smell (2.8%), feel child is enclosed or constrained (3.8%), problem with net ie, torn, old, or dirty (17.1%), chemical used in treating unsafe (2.8%), and net provokes coughing (1.0%). There were also combinations of reasons.

Only about 2,489 (48.5%) of the 5,146 under-5 children surveyed slept under a bed net. These children were in 1,202 (33.9%) of the 3,549 of surveyed households with an under-5 child. About 10% (9.7%) of these children were infants (below 12 months of age), 43% were between 12- to 35-months old, and 47.3% were between 36 to 59 months of age. More children above 2 years (35.7%) compared with those below 2 years (34.5%) slept under a bed net, although this did not reach statistical significance ($P = 0.573$).

The proportion of male children (35.6%) compared with female (35.2%) who sleep under a bed net was not significantly different ($P = 0.824$). The birth rank of a child had no significant effect on whether a child slept under the bed net or not. For those who were first born, the proportion that slept under a bed net vs those that did not was 34% vs 66%; for second or third birth ranks, this was 36.1% vs 63.9%; for the fourth, fifth, or sixth birth rank, this was 40% vs 60%; and this was 38.5% vs 61.5% for those who were ranked 7th or greater ($P = 0.079$). Households with two or more under-5 children had a significantly higher number of children sleeping under a bed net (59.0%) compared with that in households with only one under-5 child (41.0%) ($P = 0.001$) (Table 6).

Table 7 shows the adjusted regression analysis of variables. Children in households with two or more under-5 children were 1.26 times more likely to sleep under bed nets than those with only one under-5 child (odds ratio [OR] = 1.26; CI: 1.05−1.66). Under-5 children in families whose household

**Table 6** Proportion of under-5 children that sleeps under a bed net

| Characteristics | N (%) | Child sleeps under bed net | | *P*-value |
|---|---|---|---|---|
| | | No | Yes | |
| **Household-level variable** | | | | |
| Age household head (years) | | | | |
| Less than 29 | 411 (12.1) | 60.1 | 39.9 | 0.001* |
| 30–49 | 2010 (59.1) | 61.9 | 38.1 | |
| 50 or more | 983 (28.8) | 71.6 | 28.4 | |
| Sex of household head | | | | |
| Male | 3013 (88.5) | 73.9 | 26.1 | 0.001* |
| Female | 391 (11.5) | 63.3 | 36.7 | |
| Educational level of household head | | | | |
| None | 1328 (39.4) | 55.8 | 44.2 | 0.001* |
| Primary | 741 (22.0) | 69.0 | 31.0 | |
| Secondary or higher | 1299 (38.6) | 70.8 | 29.2 | |
| Wealth index of household | | | | |
| Poor | 1246 (36.6) | 55.6 | 44.0 | 0.001* |
| Middle | 705 (20.7) | 57.0 | 43.0 | |
| Rich | 1453 (42.7) | 75.8 | 24.2 | |
| Number of sleeping rooms in household | | | | |
| 1 | 841 (24.8) | 69.0 | 31.0 | 0.400 |
| 2 | 1217 (38.8) | 63.5 | 36.5 | |
| 3 | 615 (18.1) | 60.0 | 40.0 | |
| 4 or more | 724 (21.3) | 64.5 | 35.5 | |
| Number of persons living in household | | | | |
| 1–3 | 439 (12.9) | 64.9 | 35.1 | 0.234 |
| 4–6 | 1581 (46.5) | 65.8 | 34.2 | |
| 7 or more | 1384 (40.6) | 62.9 | 37.1 | |
| Household surroundings sprayed in the last 1 year | | | | |
| No | 3356 (99.0) | 64.5 | 35.5 | 0.120 |
| Yes | 33 (1.0) | 51.5 | 48.5 | |
| How household acquired bed net | | | | |
| Paid for | 339 (28.6) | 30.4 | 69.6 | 0.450 |
| Free of charge | 1427 (37.2) | 32.5 | 67.5 | |
| Household has any of electricity, AC, fan or generator set | | | | |
| No | 2358 (40.5) | 48.1 | 51.9 | 0.001* |
| Yes | 3461 (59.5) | 58.2 | 41.8 | |
| Location of household | | | | |
| Urban | 996 (19.2) | 74.1 | 25.9 | 0.001* |
| Rural | 2408 (80.8) | 60.5 | 39.5 | |
| Region of household | | | | |
| North Central | 587 (17.4) | 77.3 | 22.7 | 0.000* |
| North East | 616 (18.1) | 39.3 | 60.7 | |
| North West | 737 (21.7) | 49.4 | 50.6 | |
| South East | 430 (12.6) | 78.6 | 21.4 | |
| South West | 646 (19.0) | 70.3 | 29.7 | |
| South South | 388 (11.2) | 88.7 | 11.3 | |
| **Child-level variable** | | | | |
| Age of child | | | | |
| Less than 24 months | 1070 (20.8) | 65.5 | 34.5 | 0.573 |
| 24–59 months | 4076 (79.2) | 64.3 | 35.7 | |
| Sex of child | | | | |
| Male | 2594 (50.4) | 64.4 | 35.6 | 0.824 |
| Female | 2552 (49.6) | 64.8 | 35.2 | |

(*Continued*)

**Table 6** (*Continued*)

| Characteristics | N (%) | Child sleeps under bed net | | *P*-value |
|---|---|---|---|---|
| | | No | Yes | |
| Birth rank of child | | | | |
| 1st | 1292 (25.1) | 66.0 | 34.0 | 0.079 |
| 2nd–3rd | 1554 (30.2) | 63.9 | 36.1 | |
| 4th–6th | 1564 (30.4) | 60.0 | 40.0 | |
| 7th and above | 736 (14.3) | 61.5 | 38.5 | |
| Number of under-5 children in households | | | | |
| 1 | 2110 (41.0) | 51.4 | 48.6 | 0.001* |
| 2 or more | 3036 (59.0) | 45.7 | 54.3 | |

**Note:** *P-values are statistically significant.
**Abbreviation:** AC, air conditioner.

heads were less than 29 years and between 30–49 years were 2.79 and 1.60 times, respectively more likely to sleep under a bed net compared with households with a head who was 50 years and above ([OR = 2.79; CI: 1.65–4.79] and [OR = 1.60; CI: 1.17–2.19]). Similarly, families whose household head was female were 1.61 times more likely to put a child under a bed net during sleep than families whose household head was male (OR = 1.61; CI: 1.00–2.61). Children were also 1.07 and 1.12 times more likely, respectively, to sleep under a bed net in families whose head had primary education and postprimary education (secondary and higher education) compared with those with no form of education ([OR = 1.07; CI: 0.72–1.57] and [OR = 1.12; CI: 0.76–1.66]).

Families in the poor wealth class (OR = 1.77; CI: 1.03–3.04) and families in the middle wealth class (OR = 1.43; CI: 0.94–2.18) were 1.77 and 1.43 times, respectively, more likely to put an under-5 child under a bed net during sleep than a family in the rich class.

Analysis also showed that it was 0.23 times and 0.20 times less likely for a child under-5 years to sleep under a bed net in families with 4–6 and 7 or more households members (aside from the under-5s) compared with households with 1–3 households members ([OR = 0.23; CI: 0.08–0.69] and [OR = 0.20; CI: 0.07–0.61]) respectively. Under-5 children who resided in households where the surrounding had been fumigated in the previous 1 year were 1.47 times (OR = 1.47; CI: 0.53–4.07) more likely to sleep under a bed net than those in households that had not been fumigated. Also, under-5s in households who paid for their bed net were 1.07 times (OR = 1.07; CI: 0.77–1.50) more likely to sleep under a bed net than those in households who got their bed nets free of charge. However, these findings were not statistically significant.

Just like families in the higher wealth category, children in households that had electricity, generator sets, air

**Table 7** Odds ratio and 95% confidence interval for bivariate logistic regression models

| Variables | Model 1 | Model 2 |
|---|---|---|
| | Child level | Household level |
| | OR (95% CI) | OR (95% CI) |
| **Child characteristics** | | |
| Age of child | | |
| Less than 24 months | 0.97 (0.73–1.38) | 0.94 (0.69–1.28) |
| 24–59 months | 1 | 1 |
| Sex of child | | |
| Male | 1 | 1 |
| Female | 1.12 (0.90–1.41) | 1.2 (0.94–1.54) |
| Birth rank of child | | |
| 1st | 1 | 1 |
| 2nd–3rd | 0.96 (0.70–1.33) | 0.93 (0.65–1.33) |
| 4th–6th | 1.06 (0.78–1.45) | 0.86 (0.59–1.25) |
| 7th and above | 0.99 (0.68–1.46) | 0.68 (0.43–1.07) |
| Number of under-5 children in households | | |
| 1 | 1 | 1 |
| 2 or more | 1.32 (1.01–1.72)* | 1.26 (1.05–1.66)* |
| **Household characteristics** | | |
| Age of household head (years) | | |
| Less than 29 | | 2.79 (1.65–4.70)* |
| 30–49 | | 1.60 (1.17–2.19)* |
| 50 or more | | 1 |
| Sex of household head | | |
| Male | | 1 |
| Female | | 1.61 (1.00–2.61)* |
| Educational level of household head | | |
| None | | 1 |
| Primary | | 1.07 (0.72–1.57) |
| Secondary or higher | | 1.12 (0.76–1.66) |
| Wealth index of household | | |
| Poor | | 1.77 (1.03–3.04)* |
| Middle | | 1.43 (0.94–2.18) |
| Rich | | 1 |
| Number of bed nets in household | | |
| 1 | | 1 |
| 2 or more | | 2.03 (1.56–2.66)* |
| Number of persons living in household | | |
| 1–3 | | 1 |
| 4–6 | | 0.23 (0.08–0.69)* |
| 7 or more | | 0.20 (0.07–0.61)* |
| Household surroundings sprayed in the last 1 year | | |
| No | | 1 |
| Yes | | 1.47 (0.53–4.07) |
| How household acquired bed net | | |
| Paid for | | 1.07 (0.77–1.50) |
| Free of charge | | 1 |
| Amount spent on bed net in the last one year (US$) | | |
| Less than 4 | | 1 |
| 4–10 | | 1.18 (0.69–2.00) |
| More than 10 | | 0.96 (0.37–2.52) |
| Household has any electricity, AC, fan or generator | | |
| No | | 1 |
| Yes | | 0.91 (0.62–1.36) |

(*Continued*)

**Table 7** (*Continued*)

| Variables | Model 1 | Model 2 |
|---|---|---|
| | Child level | Household level |
| | OR (95% CI) | OR (95% CI) |
| Location of household | | |
| Urban | | 0.99 (0.72–1.40) |
| Rural | | 1 |
| Region of households | | |
| North Central | | 1 |
| North East | | 2.72 (1.52–4.87)* |
| North West | | 7.7 (4.28–13.95)* |
| South East | | 5.38 (3.08–9.37)* |
| South South | | 3.18 (1.77–5.71)* |
| South West | | 4.10 (2.39–7.04)* |

**Note:** *P-values are statistically significant.
**Abbreviations**: AC, air conditioner; CI, confidence interval; OR, odds ratio.

conditioners, or an electric fan were 0.9 times less likely to sleep under a bed net than those without this items (OR = 0.9; CI: 0.62−1.36). There was no significant difference in the likelihood of an under-5 child sleeping under a bed net in families residing in rural areas compared with those in urban areas (OR = 0.99; CI: 0.72−1.40); however, there was a remarkably higher likelihood for under-5 children in households located in the North East (OR = 2.72; CI: 1.52−4.87), North West (OR = 7.70; CI: 4.28−13.95), South East (OR = 5.38; CI: 3.08− 9.37), South South (OR = 3.18; CI: 1.77−5.71), and South West regions (OR 4.10; CI: 2.39−7.04) to sleep under a bed net compared with those in the North Central region of Nigeria.

## Malaria parasitemia and bed net use

A malaria smear was done on 940 of the under-5 children in the survey. Table 8 shows that 344 tested positive, giving a parasitemia rate of 38.1%. There was no significant difference in the proportion of children who tested positive based on the type of bed net used, treated 35% vs untreated 10% ($P = 0.103$). This may be attributed to the small sample size of under-5s in the untreated category.

There were 194 (41.9%) and 269 (58.1%) under-5 children in households with no bed net compared with 152 (34.2%) and 293 (65.8%) of children in households that owned at least one bed net that tested positive and negative respectively for malaria on the smear test ($P = 0.016$). Similarly, more children 236 (39.7%) who did not sleep under a bed net tested positive to malaria test compared with 108 (35.0%) who slept under a bed net ($P = 0.292$); however, this did not reach statistical significance (Table 8). Children above 2 years had a higher malaria prevalence than those under

**Table 8** Malaria parasitemia and household variables

| Parameters Household variables | Blood smear result for malaria parasite | | Total | *P*-value |
|---|---|---|---|---|
| | Negative n (%) | Positive n (%) | N (%) | |
| **Household has at least a bed net** | | | | |
| No | 269 (58.1) | 194 (41.9) | 463 (100) | 0.016* |
| Yes | 293 (65.8) | 152 (34.2) | 445 (100) | |
| **Child sleeps under a bed net** | | | | |
| No | 359 (60.3) | 236 (39.7) | 595 (100) | 0.292 |
| Yes | 201 (65.0) | 108 (35.0) | 309 (100) | |
| **Type of bed net** | | | | |
| Treated | 134 (65.0) | 72 (35.0) | 206 (100) | 0.103 |
| Untreated | 9 (90.0) | 1 (10) | 10 (100) | |
| **Age of child** | | | | |
| Less than 24 months | 79 (67.5) | 37 (31.6) | 117 (100) | 0.011* |
| 24–59 months | 486 (61.0) | 311 (39.0) | 797 (100) | |
| **Sex of child** | | | | |
| Male | 276 (62.0) | 169 (38.0) | 445 (100) | 0.620 |
| Female | 289 (61.6) | 179 (38.2) | 469 (100) | |
| **Wealth index of household** | | | | |
| Poor | 153 (49.5) | 156 (50.5) | 309 (100) | 0.001* |
| Middle | 109 (55.1) | 89 (44.9) | 198 (100) | |
| Rich | 303 (74.6) | 103 (25.4) | 406 (100) | |
| **Household surroundings fumigated** | | | | |
| No | 556 (62.1) | 340 (37.9) | 896 (100) | 0.689 |
| Yes | 6 (50) | 6 (50) | 12 (100) | |
| **Household location** | | | | |
| Urban | 222 (80.4) | 54 (19.6) | 276 (100) | 0.001* |
| Rural | 343 (53.8) | 294 (46.2) | 638 (100) | |
| **Region of household** | | | | |
| North Central | 92 (55.4) | 74 (44.6) | 166 (100) | 0.001* |
| North East | 71 (53.8) | 61 (46.2) | 132 (100) | |
| North West | 88 (46.1) | 103 (53.9) | 191 (100) | |
| South East | 63 (61.8) | 39 (38.2) | 102 (100) | |
| South West | 86 (64.7) | 47 (35.3) | 133 (100) | |
| South South | 85 (44.3) | 107 (55.7) | 192 (100) | |

**Note:** *P-values are statistically significant.

2 (39.0% vs 31.6%) ($P = 0.011$), and there was no significant difference in prevalence among the children based on sex, male vs female (38.0% vs 38.2%) ($P = 0.620$).

More children in the rural area tested positive to malaria, 294 (46.2%), compared with 54 (19.6%) children in the urban area ($P < 0.05$). As expected, children in the poorest households had the highest proportion of malaria positive test results, 156 (50.5%) compared with 89 (44.9%) and 103 (25.4%) of children in households in the middle and richest wealth category, respectively ($P = 0.001$). Malaria smear test results (positive vs negative) amongst under-5 children were 74 (44.6%) vs 92 (55.4%) in the North Central region, 61 (46.2%) vs 71 (53.8%) in the North East, and 103 (53.9%) vs 88 (46.1%) in the North West region of northern Nigeria.

In the southern half, the South South region had the highest prevalence of malaria in children, with 107 (55.7%) vs 85 (44.3%), followed by the South East, with 39 (38.2%) vs 63 (61.8%) and the South West, with 47 (35.3%) and 86 (64.7%).

## Discussion

The households bed net ownership rate from this study was about 45.5% in Nigeria. This is far below the Roll Back Malaria (RBM) and Millennium Development Goal (MDG) 6 target of 80% coverage of household ownership of bed net by 2015[19] but a big leap from the 8.0%−10.0% reported by the WHO[20] in 2005. A multicountry study done in 2008 showed that four countries had household ownership coverage of 80.0% or more for the at-risk population; six countries were between 60.0% and 80.0%; nine were between 40.0% and 60.0%; 12 were between 20.0% and 40.0%; and 13 were below 20.0%.[21] The study further showed that countries that received the most health aid for malaria programs had the fastest scale up of bed net distribution,[21] and in conclusion, it stated that each US$ 1 per capita in health aid spent on malaria efforts was associated with a rise in household bed net ownership and use in children under-5 of 5.3% and 4.6% points, respectively.[21] The ownership and use of bed net was shown, in this study, to significantly reduce the proportion of malaria parasitemia among under-5 children within households, just as reported in a similar work in Malawi.[10]

The recent successes in Kenya and other African countries have shown that with good funding, political will, and a good distribution network the MDG 6 target of 80% coverage can well be exceeded.[11,22] Until 2012, over 45 million bed nets had been distributed by the Nigeria government in partnership with the Global Fund and other international organizations, making this the largest bed net distribution program anywhere in the world.[23] Furthermore, as recently as August 2012, an additional 225 million dollars was committed to control measures against malaria by the Global Fund, and the State and Federal governments of Nigeria.[23] For a country with a population of close to 160 million, these efforts, though substantial, are far from adequate. However, if properly managed, these funds will, to a great extent, provide more bed nets and other malaria control measures to the most vulnerable group in the country.

The findings from this study also showed that only 48.5% of children surveyed in 33.9% of surveyed households slept under a mosquito bed net. Though this was a good improvement compared with a similar survey[24] done in 18 African countries (which puts the rate at between 0.7%−39.2%) in 2009, it is, however, still unacceptably low and falls short of the 60% target of bed net coverage by 2005 for under-5 children, set by the African head of states in Abuja[19] eleven years ago. Seven years after the RBM target declaration in Abuja, many African countries have yet to meet up. A survey done in 2007 in 44 African countries showed that 90 million African children still do not sleep under a bed net, and a quarter of these children are Nigerian.[25]

Distribution of bed nets free of charge was a necessary strategy to scale up bed net uptake but not usage based on the findings of this study. Under-5 children in more than a third of households that owned a bed net did not sleep under them. Similar to a study[26] in a south eastern state in Nigeria, the most common reasons for nonusage according to the study were that "bed net was difficult to hang," "room being too hot," "no mosquitoes in the room," and "problem with bed net" (ie, bed net being too old, torn, or too dirty). Others included "fear that bed net is dangerous," "provokes cough due to chemical used in treatment," and "smell emanating from the treated nets." These concerns could be allayed if proper education of household heads is done during bed net distribution and during regular follow-up visits. It can be concluded from this study that it is imperative that bed nets should not just be distributed freely to households, but efforts should also be made to educate household members on its safety and on how to use, hang, and maintain these nets.

Contrary to finding of other studies,[27,28] in some African countries, bed net ownership occurred more in rural areas than in the urban areas in Nigeria. The most probable reason is the emphasis in the Abuja declaration of 2001 on the free net distribution in rural areas due to the higher death rate from malaria in rural areas[29] − reflected in this study by the significantly higher parasitemia rate in these areas (Table 8). A second but less cogent reason will be that it is easier to gather, address, and disseminate messages in rural settings through local chiefs and village heads than in urban settings. Finally, due to the high urban population and limited living spaces, households tend to have higher numbers of people living within a household in urban than in rural areas. This factor (number of household members aside from the under-5 children) was seen in this study to be a very strong factor that decreased the likelihood of bed net usage by under-5 children within households.

The age and sex of household heads were also important determinants in the usage of bed net by an under-5 child. Younger household heads tended to use bed nets more than older heads. This is not surprising, as exposure to media, internet, trends, and even better use of hospital facilities by

younger people increases the chances of being informed about the bed net program, of receiving bed nets, and of usage over that in older people, who usually are more resistant to new inventions and interventions. Female house heads also tended to be more likely to put an under-5 child under a bed net during sleep than were male households heads. Because most women and mothers are usually better in carrying out routine household chores and health-related activities, especially those related to the child,[30,31] like use of a bed net and/or drug administration, than males, it is therefore not surprising that an under-5 child is more likely to sleep under a bed net in households where a woman is the head than those with males as their head.

Unlike the findings in the study by Ruhago et al in Tanzania,[32] wealthy house households were less likely to own and use a bed net in Nigeria compared with poorer households. Most inhabitants of wealthy households, who usually live in their own houses, usually take preventive measures, like proper netting of doors and windows, good environmental hygiene (which is a major measure against breeding of mosquitoes), and in some cases, frequent use of indoor insecticide sprays and outdoor fumigation, all of which most poor households cannot afford. These measures minimize or in many cases, completely eradicate mosquitoes from the home and its vicinity, making the use of a bed net unnecessary. This is in contrast to poorer households, where the luxuries of a comfortable apartment and associated preventive measures against mosquitoes are unlikely, thus necessitating the need and use of a bed net among under-5 children within these households. This was reflected in the significantly lower parasitemia rate in richer households compared with the poor households, found in this study.

As expected, children in households with two or more under-5 children and in households with two or more bed nets tended to sleep under a bed net more than those with one under-5 child and/or one bed net. This reinforces the need to increase bed net delivery to households, not on a fixed quantity basis, but based on the needs and number of children within such households. However, the question of sustainability and misuse comes into question here.

The household bed net coverage in all six regions in Nigeria was below the 80% RBM target. Households in the North Central region had the lowest bed net ownership rate, and under-5 children in these households were the least likely to use bed nets in northern Nigeria. Based on the findings of this study, one could attribute this to the lower malaria parasitemia rate in this region compared with the other northern regions of Nigeria (Table 8). However, this reasoning was not tenable in the southern part of Nigeria, where the swampy South South region, which had the highest parasite rate as one would expect, had the lowest ownership rate and bed net usage of the southern regions. Even though one cannot give an explicit explanation for this trend in the south, one could, however, speculate that the poor distribution networks, due to the swampy nature and difficult terrains in the South South region (which is only accessible by boats and canoe) coupled with the unrest in the Niger delta region (due to oil exploration and exploitation) may explain the poor household bed net ownership and subsequent usage amongst under-5 children in the Niger delta region. Nevertheless, the use of bed nets for the under-5 children was significantly higher in households that owned a bed net in the South South region compared with the North Central and North East region.

## Limitations

Given the cross-sectional design of this survey, the information on bed net use in under-5 children within households could only be acquired from the questions relying on a recall of whether child had slept under a bed net the previous night. Therefore, this information was only obtained from mothers at the time of interview. Several misclassifications leading to selection bias might have occurred since an under-5 child who usually slept under a bed net but who, for some reason, did not sleep under a bed net the previous night before the interview day was considered to be not sleeping under a bed net, and vice versa. Similarly, due to a limitation of reverse causation in cross-sectional studies, an association and/or causal effect between household ownership with or without use of a bed net by an under-5 and malaria parasitemia level in households cannot be ascertained. One cannot say with certainty which one precedes the other. It is therefore recommended that the study results be interpreted with caution.

# Conclusion

Despite its limitations, this study showed that ownership and use of a bed net among under-5 children significantly reduces malaria parasitemia and hence the risk of malaria infection in this group. It therefore reiterates the need to enhance and increase the bed net distribution in Nigeria, the most populous nation in Africa, and to educate people from all regions, sex, religious, and cultural background on the need to acquire and use a bed net, especially among the most vulnerable in our society. Based on the reasons for nonuse of bed net among under-5s in households that owned a bed net, as seen in this study, the Nigerian government and supporting international organizations should honor their promise and commitment to

the fight against malaria in Africa by not only scaling up the provision and distribution of bed nets, but by also ensuring proper and focused public enlightenment campaigns targeting the regions and household categories with poor uptake and usage of this life-saving intervention.

## Acknowledgments and funding

The authors would like to thank the officials of the Opinion Research Company (ORC) and the owners of the Demographic and Health Survey for their kind assistance in permitting us to use the data used in this study, and the Nigeria Federal Ministry of Health and National Population Commission for their ethical clearance. The contents of this study are solely the responsibility of the authors and are in no way representative of the official views of the ORC.

## Disclosure

The authors report no conflicts of interest in this work.

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