

Determinants of Childhood Malaria Morbidities in Nigeria: Secondary Analysis of 2015 Malaria Indicator Survey

Abstract

Background: In Nigeria, malaria remains an important public health problem accounting for 25% of infant mortality, 30% of under-five mortality and 11% of maternal mortality. Between 2000 and 2010, at least 50% of the population had an episode of malaria per year while under-five children had 2-4 episodes. Currently, malaria parasite prevalence is still high with an average prevalence of 45.0%.

Methods: This study was a cross-sectional survey utilizing data from the Nigeria 2015 MIS. The outcome variables were a fever in the past two before the survey, positive blood smear for malaria parasite and positive rapid malaria diagnostic test (RDT). Statistical analysis was the survey logistic regression.

Results: A total number of 6632 children and 8034 mothers were used for the analysis. Overall, prevalences of fever, malaria parasitaemia and positive RDT are 41%, 27% and 45% respectively. Significant and uniform determinants of the three outcomes are: geopolitical zone, place of residence, wealth quintile and indoor residual spray; other maternal factors are preventive practices and knowledge of malaria prevention.

Conclusion: Socio-economic status and maternal knowledge of malaria prevention are important factors that influence childhood malaria morbidities. These factors need to be taken into consideration when planning malaria control programmes in order to have effective programmes.

Keywords: Childhood malaria, Determinant, Logistic regression, Nigeria, MIS

1. INTRODUCTION

Malaria is by far the most important vector-transmitted disease in the world. The infection especially in children is characterized by fever, chills, rigor and sometimes even seizures. There are about 300-500 million cases reported annually with more than 1 million people who die from the disease, most of them children under five years of age. [1] Over 90% of cases and 75% of deaths occur in Sub-Saharan Africa (SSA). These childhood deaths resulting mainly from cerebral malaria and anaemia constitutes between 20% and 25% of child mortality in Africa. [2] Malaria transmission in Africa is governed by the existence of mosquitoes of *Anopheles gambiae* Giles complex which are highly efficient vectors. [3] It is estimated that 70% of the total sub-Saharan population lives in areas infected with malaria

33 vectors, thus it is not surprising that 90% of all clinical cases and about 90% of deaths caused
34 by the disease are reported in this region. [4, 5] Majority of people in Africa live in areas
35 where malaria transmission is intense and occurs throughout the year, thus with time some
36 degree of immunity to malaria develops. [6] In such areas young children and pregnant
37 women are at greatest risk of malaria infection and death due to low levels of immunity.

38 Malaria is both a social and economic burden not only to the country, but to
39 individuals and families. SSA bears the heavy burden of malaria as these countries are among
40 the poorest in the world and the widespread poverty in the continent continues to play a role
41 in the disease burden. It is reported that malaria slows economic growth in African countries
42 by 1.3% of the population annually [7] and the effects are worse in rural communities where
43 economic activities are centred on family members. The annual economic loss to SSA due to
44 malaria is up to 12 billion dollars. [8]

45 Malaria is transmitted by the bite of female Anopheles mosquito which needs proteins
46 from a blood meal to produce a batch of eggs. The mosquito is highly anthropophilic and
47 bites indoors (endophagy). The disease is caused by protozoan parasites of the genus
48 Plasmodium; the most prevalent and most deadly is *P. falciparum* which accounts for the
49 majority of deaths due to malaria globally. [9] It is a major cause of morbidity and mortality
50 and the main reason for a visit to health facilities, in-patient admissions and is responsible for
51 most deaths of pregnant women and children under five years of age in Nigeria. [11, 12]
52 Malaria is responsible for 110 million clinical cases in Nigeria, 60% of all outpatient clinic
53 attendances, 30% of all hospital admissions and 300, 000 deaths per year. [13] **Current**
54 **estimates of annual death due to malaria are less than 500,000. Please cite the latest WHO**
55 **World Malaria Report 2017**. However, it remains a major cause of morbidity in children in
56 SSA with 10% of all deaths of children U5 due to malaria. That means a child dies of malaria
57 every 2 minutes in SSA. [14] Malaria is associated with environmental/ climatic factors
58 (rainfall, altitude and temperature) [15, 16] which affects both the parasite and the mosquito.
59 Mosquitoes are unable to survive in low humidity while rainfall provides breeding sites and
60 increases humidity which enhances their survival. Plasmodium parasites are affected by
61 temperature where their development slows as temperature drops and stops at high
62 temperatures.

63 In Nigeria, malaria remains an important public health problem accounting for 25% of
64 infant mortality, 30% of U5 mortality and 11% of maternal mortality [13] respectively.

65 Between 2000 and 2010, at least 50% of the population had an episode of malaria per year
66 while children U5 had 2-4 episodes. [17] Prior to 2010, available data was insufficient to
67 clearly micro-stratify the country's malaria epidemiological profile. However, the 2010
68 Nigeria Malaria Indicator Survey (NMIS) revealed that malaria parasite prevalence is still
69 high with an average prevalence of 42.0% among children U5 years of age with zonal
70 variations ranging from 27.6% in the South-east to 50.3% in the South-west zone. [18] The
71 2015 NMIS shows a decreasing trend with average parasite prevalence of 27.4% and zonal
72 variations ranging from 14.0% in South-east to 37% in North-west. [19] Substantial
73 investments have been made in Nigeria by the Government and partners on malaria. Nigeria
74 was one of the countries included in WHO large-scale malaria control initiative between
75 1955 and 1969 (Malaria Eradication Programme) that relied on indoor residual spraying
76 (IRS) of DDT (Dichloro-diphenyl-trichloroethane). [13] WHO, UNICEF and partners
77 developed a simple, affordable and effective intervention for the integrated management of
78 major childhood illnesses (IMCI). [19] Thus malaria management will be through community
79 systems (integrated community case management) and ward minimum health package.
80 Furthermore, Nigeria launched National Malaria Strategic Plans (NMSP), 2001-2005, 2006-
81 2010, 2009-2013 and 2014-2020 respectively.

82 The NMSP 2009-2013 aimed at malaria control through three interventions;
83 prevention of malaria transmission through integrated vector management (IVM) strategy,
84 prompt diagnosis and adequate treatment of clinical cases and prevention and treatment of
85 malaria in pregnancy. During this period over 60 million long-lasting insecticidal nets
86 (LLINS) were distributed. [18] The 2014-2020 NMSP presents a major scale-up of key
87 interventions that aim to achieve pre-elimination status and reduction of malaria-related
88 deaths to zero by 2020 in Nigeria. [18] In line with this, the Government re-designed the
89 National Malaria Control Programme (NMCP) to National Malaria Elimination Programme
90 (NMEP). Despite all these measures put in place by government and other stakeholders to
91 effectively reduce the number of malaria cases and deaths among U5 children in Nigeria over
92 the decades, the prevalence is still high. Therefore in order to apply successful
93 implementations to substantially reduce the burden of malaria, there is a need to continuously
94 understand the epidemiology and determinants associated with malaria. Also, malaria
95 interventions usually target households, individuals and the environment. This necessitates
96 the use of multi-level analyses to identify factors associated with malaria that can be used by
97 governments and stake holders for programme intervention and or scale up in order to

reduce/eliminate the scourge of this disease. Globally, a number of studies have identified a range of factors associated with malaria infection; socio-economic, demographic and environmental etc [16, 21-24], it is pertinent to identify these factors and their influence in the Nigerian context. From the study of Fenn et. al, it can be concluded that it is possible to have a significant co-occurrence of illness at the community level. The bivariate probit procedure was easily adopted and considered appropriate for the analysis of comorbidity. The lack of suitable datasets for a more thorough analysis of comorbidity, and for the evaluation of synergistic effects on mortality, it can be said as assigned major limitation^[40]

It is believed that routine use of parenteral antibiotics among children with a slide that indicates malaria and life-threatening disease is warranted because invasive bacterial infections are likely to be under-ascertained and are associated with increased mortality. Published data on co-morbidity with HIV infection and malnutrition are reviewed^[41]

Most previous studies [10, 25- 27] have either been based in institutions or local communities, hence the use of demographic and health survey (DHS) data which has a large sample size and nationally representative that allows for generalization of findings for national policy formulation and programme intervention. Thus the aim of this secondary analysis was to investigate the determinants of childhood malaria morbidity-fever in the past two weeks prior to the survey, parasitaemia using microscopy and positive malaria test using rapid diagnostic test (RDT) in children under five years of age in Nigeria.

2. METHODS

2.1 Study Area

Nigeria is situated in West African sub-region lying between latitudes 4°16' and 13°53' north and longitudes 2°40' and 14°41' east. It has the Niger Republic to its northern border, Chad to its Northeast, the Republic of Cameroun at its Eastern border and Benin Republic to its West. To its Southern border is an 850 kilometre stretch of the coastal area provided by the Atlantic Ocean. Nigeria has a landmass of approximately 923,768square kilometres. It is traversed by two popular and long rivers: River Nigeria running from North West and River Benue running from North East joining together at Lokoja to a confluence before travelling southwards to empty into the Atlantic Ocean through the Niger Delta. Nigeria has an estimated population of 177 million in 2016 making it the seventh in the world and largest in Africa. It has three major ethnic groups: Hausa, Igbo and Yoruba. The diverse nature of climatic and topographic conditions of Nigeria supports malaria transmission all year round.

The World Malaria Report of 2016 indicates that the entire population of Nigeria is at risk of malaria while 76% is at high risk.

2.2 Data

The data for this study comes from the 2015 Nigeria MIS. The 2015 Nigeria MIS was carried-out between October and November 2015 and implemented by National Malaria Elimination Programme (NMEP), the National Population Commission (NPopC), the National Bureau of Statistics (NBS), and the Malaria Partnership in Nigeria. It involved a nationally representative sample of more than 8,000 households in 329 clusters and women aged 15-49 years in these households were eligible for individual interviews. During the interviews, respondents were asked questions about malaria prevention during pregnancy and treatment of fever among their children. Children aged 6 to 59 months were tested for anaemia and malaria using finger-or heel-prick blood samples. The survey is a two-stage sampling scheme to provide most of the indicators at the national level. In the first stage, nine clusters (EAs) were selected from each state (from a list of 36 states), including the FCT (Federal Capital Territory). A total of 333 clusters throughout the country were finally selected, 138 in urban areas and 195 in rural areas. In the second stage of the sampling scheme, 25 households were selected in each cluster by equal probability systematic sampling. All women aged 15-49 who were either permanent residents of the households in the 2015 NMIS sample or visitors present in the households on the night before the survey were eligible to be interviewed. In addition, all children age 6-59 months were eligible to be tested for malaria and anaemia.

2.3 Statistical methodology

2.3.1 Variables

The primary outcome variables are fever in children in the previous two weeks before the survey, malaria parasitaemia and positive rapid diagnostic test (RDT). The following potential predictor variables were identified: maternal age, child age (in months), household wealth index, maternal level of education, child's birth order, number of under-five children in the household, haemoglobin level of child, sleeping under IT/LINN by the child the previous night before the survey, zone, residence, household ownership of ITN/LLIN, indoor residual spray of dwelling, maternal knowledge of cause and prevention of malaria.

2.3.2 Statistical analysis

The main statistical approach was the survey adjusted logistic regression of the outcome variables and the independent variables identified above. In each case, the dependent variable (malaria morbidity) was regressed against a set of independent variables to determine the significant factors associated with any of the malaria morbidity (fever, parasitaemia and positive RDT).

3. Results

The result of the survey shows that 8034 women were interviewed in 329 clusters. The total number of children aged 6-59 involved was 6358 with a mean age of 32.8 months. Table 1 provides the descriptive statistics of individual and household characteristics of the respondents (mothers of under-five children) and under-five children. The distribution respondents (women) by wealth show an almost equal distribution in the five wealth quintiles and majority of them have at least primary school education (61%). Approximately one in ten of the respondents are the household heads. About 30% of the respondents reside in North West while only 10% are residing in South East. The majority are rural dwellers (61%). The age distribution of the children shows an almost uniform distribution of around 20% in the age groups except in the age group of 6-11months with 10% of children. Knowledge of and prevention practices show that over 87% of respondents have ever heard of malaria, 59% in the last six months before the survey, 83% knew at least one cause of malaria, 81% respectively knew of at least one prevention method of malaria and malaria in pregnancy. Overall, 44% of children slept under an LLIN/ITN the night before the survey.

Table 2 shows the percent distribution of childhood malaria morbidity by selected background characteristics. Overall, 41% of mothers report their children having a fever in the two weeks preceding the survey. Children in the age range of 24-35months old, living in rural areas, those living in North West, among mothers with no formal education and children in lowest wealth quintile are more likely to have experienced fever in the two weeks before the survey. Children with these background characteristics have highest prevalence/incidence of fever two weeks before the survey. Similarly, oldest children (48-59months old), living in rural areas as well as in North West zone; children of women with no formal education and living in a household in the lowest wealth quintile are more likely to be tested positive for both rapid diagnostic test (RDT) and microscopy. This table indicates that older age, rural and North West, lack of maternal educational and poverty increases the chances of childhood malaria infection in Nigeria. Malaria prevention practices such as ITN/LLIN ownership,

sleeping under ITN/LLIN does not appear to be protective against childhood malaria morbidity; however, spraying the household with IRS appear to protect against childhood malaria morbidity.

Tables 3, 4 and 5 show the results of the univariate and multivariate survey logistic regression of the determinants of childhood malaria morbidity. As regard Table 1, the age of the child (in months), number of under-five children in the household, haemoglobin level of child and zone are uniform determinants of childhood fever in the weeks before the survey. Older children, especially those aged 48-59months [OR=1.43; 95%CI: 1.25-1.65] are more likely to experienced fever than younger children. Living in the southern zones of the country is associated with lower risks of experiencing fever while living in the northern zones is associated with elevated risks of fever; children in rural parts of the country have increased odds of having fever compared to their urban colleagues [OR=1.41; 95%CI: 1.27-1.58]. Preventive practices appear to be protective against fever. Sleeping under ITN/LLIN is associated with decreased odds of fever [OR=0.59; 95%CI: 0.55-0.65]. So also household ownership of at least one ITN/LLIN [OR=0.81; 95%CI: 0.74-0.89], indoor residual spray (IRS) [OR=0.1; 95%CI: 0.11-0.27] and knowledge of at least one method of malaria prevention [OR=0.29; 95%CI: 0.25-0.33]. With regards to malaria parasitaemia (Table 4), only household wealth quintile and place of residence (among the selected socio-demographic characteristics) appears to be the uniform determinant in both univariate and multivariate logistic regression. Preventive practices and knowledge of preventive practices are significant determinants of malaria parasitaemia in multivariate model: household ownership of ITN/LLIN [OR=0.76; 95%CI: 0.63-0.90], IRS [OR=0.18; 95%CI: 0.04-0.87], knowledge of one cause of malaria [OR=1.43; 95%CI: 1.03-1.98] and knowledge of at least one preventive method [OR=0.64; 95%CI: 0.48-0.84]. Table 5 indicates that wealth index is a strong predictor of positive RDT test among children. Rural residence is equally a strong determinant of positive RDT test [OR=1.95; 95%CI: 1.62-2.33]. In summary, geopolitical zone, place of residence (rural/urban), household wealth quintile and indoor residual spray in the past 12 months are the consistent determinants of childhood malaria morbidity; knowledge of prevention and practice of prevention (besides IRS) are not consistent across the three models.

4. DISCUSSION

In this study, we are able to demonstrate the significant roles played by several factors in predicting three childhood malaria morbidities using the most recent Nigeria Malaria Indicator Survey data. We modelled 14 potential factors of which only two show consistencies and uniformity in their role as determinants of childhood morbidities: place of residence and indoor residual spray. However, with respect to experiencing fever in the two weeks prior to the survey (Table 3), the multivariate logistic regression show that age of the child, number of under-5 children in the households, haemoglobin level of the child, sleeping inside LLIN/ITN the previous night before the survey, zone, household ownership, household being sprayed with IRS and knowledge of malaria prevention and causes are significant determinants. With regards to parasitaemia (through microscopy), household wealth quintile, place of residence, household ownership, IRS of the household as well as knowledge of causes and prevention of malaria are the consistent determinants. Lastly, only household wealth quintile and place of residence are the significant determinants of positive RDT test for malaria in these children.

In this study, household ownership of at least one LLIN/ITN is found to be protective against fever in the past two weeks before the survey as well as parasitaemia; however, it is not protective against positive RDT. From previous studies across the world, use of LLIN/ITN has been shown to protect against malaria infection; Lengeler [29] and Gamble [30] conducted two separate Cochrane Reviews, one for general populations and one for pregnant women respectively which led to the conclusion that use of LLIN/ITN has a protective efficiency against *Plasmodium* parasitaemia of between 13% and 29% in areas of stable malaria transmission among the general population. Our study indicates that use of LLIN/ITN reduces childhood fever (from malaria) by 19% and *Plasmodium* parasitaemia by 24% showing that our results are consistent with that of the review by Lengeler [29]. Related to LLIN/ITN ownership is sleeping under the net the night before the survey. This variable has been used as a proxy for utilization of LLIN/ITN in surveys. The finding from this study indicate that sleeping under LLIN/ITN the night before the survey is protective against childhood fever only; not protective against *Plasmodium* parasitaemia or positive RDT. It has been shown that use of mosquito nets irrespective of whether it is treated or not, the number of the nets in the household and whether the child slept under it or not the night before the survey are significantly associated with child's malaria status [31 (Roberts)]. Our results are partly (with respect to childhood fever) consistent with those reported by Gahutu et al. [22] and Okabe et al. [32].

Indoor residual spray (IRS) of houses/households showed a significant protective effect against all the three childhood morbidities modelled in this study, even though the coverage of this intervention is one of the lowest in the country at only 1.3%. Indoor residual spray either alone or in combination with ITN has been shown to provide protection against malaria infection. In a systematic review published in 2010 by Pluess and colleagues [32], IRS had been demonstrated to significantly reduce malaria transmission by as much as 14% in children aged one to five years. In our study, the risk of childhood fever, Plasmodium parasitaemia and positive RDT are all significantly reduced (by between 80% and 83%) if the child lives in households that have been sprayed within the previous 12 months. Similar results were reported by Roberts (31) in which they reported that child's malaria status is significantly associated with the incidence of IRS within the last six months. Specifically, risk of malaria parasitaemia is increased over seven-fold if the household was not sprayed in the last six months.

That rural location turned-out to be a significant risk factor for malaria morbidities could be the result of the interplay of several factors operating in the rural areas. It could be lack of knowledge of prevention of malaria, lack of access to malaria prevention methods such as long-lasting insecticidal nets (LLIN)/ITN, behavioural factors of poor environmental sanitation and management of vector ecology to prevent breeding of mosquitoes as well screening of windows and doors. A living arrangement in rural areas where animals (goats, sheep, oxen and cattle) are kept and reared within the household could be associated with increased risk of malaria. Killeen and Smith TA have argued that presence of animals particularly cattle provides alternative blood meal to mosquitoes but in the absence of protective and preventive measures, they feed on humans (28). The data set used here captured household ownership of animals (goats, cattle, sheep, chickens and donkeys/horses) which showed that ownership of these animals is highest among rural dwellers than urban dwellers.

We are unable to demonstrate the important roles of wealth, the age of the child, education of the mother as reported by previous researchers (31, 34, 35) [Roberts and Mathews 2016; Ferrari et al, 2016; Ayele et al 2012]. In these investigations, it was reported that the older the child the greater the risk of malaria childhood morbidities. For instance, this relationship could be due to the fact that the older children are likely to be part of the preventive measures adopted by their mother/care givers possibly there is already a younger child being born into the family. This older child might be taken care of by older siblings while the mother focuses her efforts on the new born baby. Gahutu (22), Pullan et al. (36), and Krefis et al. (37) reported

the similar relationship between age of child and childhood malaria morbidities. Similarly, we are unable to demonstrate the effect of wealth on childhood malaria morbidities despite that fact that malaria has been shown to be a disease of the poor or disease of poverty. This claim can be substantiated by noting the global distribution of malaria where the concentration of the disease is in poorest continents and countries; and among poorest households within countries or communities. This relationship is clearly shown in Table 2 where the incidence of fever in past two weeks, parasitaemia and positive RDT decreases massively as the wealth level increases. Being a primary cause of poverty, some studies suggest that a better understanding of the relationships between malaria and poverty is needed to enable the design of coherent and effective policies and tools to tackle the problem. Since poverty is related to socio-economic factors, it is important to identify those factors that are also related to the risk of malaria (38, 39).

5. CONCLUSION

While some of the results of this study agreed with those of other studies, some are not. As pointed out at the beginning of our discussion, the only place of residence and indoor residual spray turned out to be the uniform determinants of three childhood malaria morbidities examined here. The role of IRS as an important determinant of childhood morbidity is unexpected keeping in mind that only around 1.3% of households were sprayed with IRS within the past 12 months before the survey. However, this result is indicative that IRS is a promising intervention in the control of malaria if the only small proportion of household is covered with this intervention, yet it turned out to be a significant protector against malaria.

6. LIMITATION

An important limitation of this study is the fact it utilized the Malaria Indicator Survey which was a cross-sectional study, meaning that temporal sequence of association between significant risk factors and childhood malaria morbidities could not be established. However, the study has its strengths. The complex design of the study was accounted for by including the effect of the clusters in the model as a random effect. The test of covariance parameters confirmed that accounting for this cluster effect was necessary in order to make meaningful and accurate statistical inferences. The use of a multivariate GLMM allowed an assessment of the association between the prevalence of malaria and a potential risk factor while adjusting for other variables. In this study, several important socio-economic, demographic and environmental risk factors for malaria were identified using a population-based survey.

7. ETHICAL APPROVAL

322 This study was primarily granted ethical approval by the National Health Research Ethics
 323 Committee of the Federal Ministry of Health, Abuja, Nigeria (Assigned Number
 324 NHREC/01/01/2007-11/05/2015). Permission to use the 2015 Nigeria MIS data sets was
 325 obtained from MEASURE DHS

326 **Consent is not applicable**

327

328

329 Table 1. Individual and household characteristics, Nigeria MIS 2015

Characteristic	Percentage	Number
Age of respondent		
15-19	17.1	1376
20-24	19.1	1533
25-29	20.4	1636
30-34	16.5	1325
35-39	12.1	971
40-44	9.1	729
45-49	5.8	464
Wealth index		
Poorest	18.0	1448
Poor	19.0	1530
Middle	29.5	1564
Rich	20.6	1653
Richest	22.9	1840
Education		
None education	38.8	3119
Primary	15.5	1244
Secondary	35.5	2848
More than secondary	10.2	823
Sex of head of household		
Male	87.8	3129
Female	12.3	4905
Age of child in months		
0-5	9.1	644
6-11	9.4	665
12-23	19.5	1375
24-35	19.3	1360
36-47	21.4	1511
48-59	21.2	1495
Zone		
North Central	16.9	1357
North East	13.4	1077
North West	29.4	2359
South East	10.1	811
South-South	13.5	1080
South West	16.8	1351
Residence		

Rural	61.0	4905
Urban	39.0	3129
Altitude in meters		
0-200	38.4	3082
201-400	32.8	2632
401-600	23.1	1856
601-800	4.5	364
801-1000	0.5	39
>1000	0.8	60
Ever heard of malaria		
Yes	87.4	7015
No	12.7	1016
Ever heard of malaria prevention message in past 6 months		
Yes	59.2	4153
No	40.8	2862
Knows at least one symptom of malaria		
Yes	83.2	6685
No	16.8	1346
Knows at least one cause of malaria		
Yes	87.4	7015
No	12.7	1016
Knows at least one prevention method of malaria		
Yes	81.0	6503
No	19.0	1527
Knows at least one prevention method of malaria in pregnancy		
Yes	81.0	6503
No	19.0	1527
Slept under ITN/LLIN previous night(U5)		
Yes	44.0	3496
No	56.0	444

330

331 Table 2. Percent distribution of childhood malaria morbidity by selected characteristics,
332 Nigeria MIS 2015

Characteristic	Fever past two weeks	Malaria (microscopy)	Malaria (RDT)
Age of child in months			
0-5	23.4	31.8	49.9
6-11	60.0	27.4	44.3
12-23	43.0	26.1	40.9
24-35	38.7	29.7	50.4
36-47	38.4	21.6	40.8
48-59	51.3	30.3	47.2
Wealth index			
Poorest	51.0	42.9	64.1
Poor	48.5	41.0	62.6
Middle	41.7	27.4	49.1
Rich	34.4	16.8	30.1
Richest	26.0	4.4	12.6
Education			
None education	47.6	37.7	59.7
Primary	40.3	26.2	44.3

Secondary	35.1	16.7	29.9
More than secondary	27.0	3.6	12.5
Zone			
North Central	29.9	32.0	50.7
North East	48.0	25.9	42.8
North West	52.1	37.1	58.3
South East	38.3	13.7	31.7
South-South	42.9	19.3	28.6
South West	23.5	16.6	32.1
Residence			
Rural	46.3	35.6	55.7
Urban	30.2	11.5	24.2
ITN/LLIN ownership			
Yes	43.7	27.7	46.1
No	37.6	27.2	42.4
The child slept inside ITN/LLIN previous night			
Yes	42.4	25.4	49.8
No	43.4	29.3	41.0
Household sprayed with IRS previous 12months			
Yes	8.9	10.2	15.2
No	42.7	27.6	45.5

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334

335 Table 3. Univariate and multivariate logistic regressions of determinants of fever in the past two
336 weeks before the survey, Nigeria MIS 2015

Variable	Univariate analysis Odds Ratio (95%CI)	Multivariate analysis Odds Ratio (95%CI)
Age of respondent		
15-19	1.00	1.00
20-24	1.12 (1.00-1.26)	3.52 (2.94-4.21)***
25-29	0.94 (0.84-1.06)	3.04 (2.56-3.62)***
30-34	1.37 (1.22-1.54)***	3.64 (3.04-4.37)***
35-39	0.32 (0.28-0.37)***	0.88 (0.72-1.08)
40-44	1.89 (1.60-2.23)***	4.43 (3.51-5.59)***
45-49	7.36 (5.63-9.62)***	8.75 (6.27-12.21)***
Wealth index		
Poorest	1.00	1.00
Poor	2.83 (2.61-3.07)***	2.20 (1.95-2.47)***
Middle	1.03 (0.95-1.12)	1.23 (1.08-1.40)**
Rich	0.93 (0.85-1.01)	1.34 (1.14-1.57)***
Richest	0.66 (0.60-0.72)***	0.99 (0.81-1.21)
Age of child in months		
6-11	1.00	1.00
12-23	0.50 (0.45-0.56)***	0.73 (0.64-0.84)***
24-35	0.42 (0.38-0.47)***	0.68 (0.59-0.78)***
36-47	0.41 (0.37-0.47)***	0.42 (0.36-0.48)***
48-59	0.70 (0.63-0.78)***	1.43 (1.25-1.65)***
Child birth order		
1 st	1.00	1.00
2 nd	0.74 (0.70-0.83)***	0.92 (0.81-1.04)
3 rd	0.67 (0.60-0.74)***	0.79 (0.69-0.91)**
4 th and more	1.08 (1.00-1.16)**	0.75 (0.68-0.84)***

Number of under fives		
None	1.00	1.00
One	13.94 (8.04-24.16)***	10.18 (5.20-19.93)***
Two	11.67 (6.73-20.22)***	6.46 (3.30-12.61)***
Three	9.40 (5.41-16.33)***	6.29 (3.20-12.35)***
Four and more	9.57 (5.50-16.64)***	4.92 (2.50-9.69)***
Haemoglobin level of child		
Severe anaemia	1.00	1.00
Mild anaemia	0.32 (0.28-0.37)***	0.58 (0.49-0.68)***
Moderate anaemia	1.18 (1.04-1.34)	1.33 (1.13-1.55)***
Not anaemic	0.47 (0.42-0.54)***	0.78 (0.66-0.91)***
The child slept under net last night		
No	1.00	1.00
Yes	0.97 (0.91-1.02)	0.59 (0.55-0.65)***
Education		
None education	1.00	1.00
Primary	0.98 (0.91-1.05)	1.02 (0.92-1.12)
Secondary	0.60 (0.56-0.64)***	0.97 (0.86-1.10)
More than secondary	0.74 (0.65-0.84)***	1.77 (1.43-2.18)***
Zone		
North Central	1.00	1.00
North East	1.06 (0.96-1.17)	1.88 (1.64-2.16)***
North West	1.58 (1.46-1.72)***	2.44 (2.14-2.79)***
South East	0.45 (0.40-0.52)***	0.68 (0.57-0.80)***
South-South	0.81 (0.73-0.90)***	0.84 (0.72-0.97)**
South West	0.44 (0.39-0.49)***	0.55 (0.47-0.64)***
Residence		
Urban	1.00	1.00
Rural	1.68 (1.58-1.78)***	1.41 (1.27-1.58)***
The household has at least one net		
No	1.00	1.00
Yes	1.29 (1.21-1.37)***	0.81 (0.74-0.89)***
Household sprayed with IRS		
No	1.00	1.00
Yes	0.13 (0.09-0.19)***	0.17 (0.11-0.27)***
Knowledge of malaria cause		
No	1.00	1.00
Yes	1.22 (1.12-1.33)***	3.94 (3.30-4.71)***
Knowledge of malaria prevention		
No	1.00	1.00
Yes	0.82 (1.04-1.34)**	0.29 (0.25-0.33)***

337

338 Table 4. Univariate and multivariate logistic regressions of determinants of **parasitaemia**, Nigeria
339 MIS 2015

Variable	Univariate analysis Odds Ratio (95%CI)	Multivariate analysis Odds Ratio (95%CI)
Age of respondent		
15-19	1.00	1.00
20-24	1.24 (1.03-1.50)**	1.13 (0.89-1.44)
25-29	1.01 (0.83-1.23)	1.03 (0.79-1.33)
30-34	1.09 (0.89-1.33)	0.99 (0.76-1.30)
35-39	1.15 (0.93-1.43)	1.45 (1.08-1.93)**
40-44	0.64 (0.49-0.84)***	0.78 (0.56-1.09)

45-49	0.97 (0.72-1.32)	0.88 (0.601-1.28)
Wealth index		
Poorest	1.00	1.00
Poor	0.69 (0.59-0.81)***	0.81 (0.66-1.00)*
Middle	0.52 (0.44-0.61)***	0.78 (0.61-0.99)*
Rich	0.29 (0.24-0.36)***	0.52 (0.38-0.70)***
Richest	0.07 (0.05-0.09)***	0.11 (0.07-0.18)***
Age of child in months		
6-11	1.00	1.00
12-23	0.94 (0.73-1.19)	1.02 (0.77-1.36)
24-35	1.12 (0.88-1.42)	1.19 (0.90-1.56)
36-47	0.73 (0.58-0.92)**	0.86 (0.65-1.13)
48-59	1.15 (0.92-1.45)	1.25 (0.96-1.64)
Child birth order		
1 st	1.00	1.00
2 nd	0.75 (0.62-0.90)***	0.83 (0.64-1.06)
3 rd	1.16 (0.95-1.41)	0.93 (0.72-1.19)
4 th and more	1.05 (0.90-1.23)	0.76 (0.63-0.93)**
Number of under fives		
None	1.00	1.00
One	1.14 (0.96-1.37)	1.03 (0.83-1.28)
Two	1.66 (1.40-1.98)***	0.96 (0.76-1.20)
Three	1.38 (1.12-1.71)***	0.96 (0.73-1.28)
Four and more	1.79 (1.44-2.23)***	0.87 (0.63-1.20)
Haemoglobin level of child		
Severe anaemia	1.00	1.00
Mild anaemia	0.55 (0.40-0.75)***	0.62 (0.43-0.89)**
Moderate anaemia	1.13 (0.85-1.51)	1.05 (0.75-1.47)
Not anaemic	0.43 (0.32-0.58)***	0.57 (0.40-0.81)**
The child slept under net last night		
No	1.00	1.00
Yes	1.21 (1.08-1.37)***	0.86 (0.73-1.02)
Education		
None education	1.00	1.00
Primary	0.63 (0.54-0.73)***	0.73 (0.60-0.89)**
Secondary	0.37 (0.32-0.43)***	0.96 (0.76-1.21)
More than secondary	0.18 (0.13-0.26)***	1.01 (0.59-1.72)
Zone		
North Central	1.00	1.00
North East	0.76 (0.62-0.93)***	0.72 90.57-0.93)**
North West	1.25 (1.07-1.46)***	0.93 (0.73-1.18)
South East	0.34 (0.26-0.45)***	0.71 (0.50-1.01)
South-South	0.51 (0.40-0.64)***	0.84 (0.62-1.13)
South West	0.38 (0.31-0.48)***	0.85 (0.63-1.15)
Residence		
Urban	1.00	1.00
Rural	4.31 (3.69-5.03)***	1.79 (1.44-2.22)***
The household has at least one net		
No	1.00	1.00
Yes	0.97 (0.86-1.11)	0.76 (0.63-0.90)***
Household sprayed with IRS		
No	1.00	1.00
Yes	0.30 (0.15-0.59)***	0.18 (0.04-0.87)**
Knowledge of malaria cause		
No	1.00	1.00

Yes	0.58 (0.49-0.69)***	1.43 (1.03-1.98)**
Knowledge of malaria prevention		
No	1.00	1.00
Yes	0.52 (0.49-0.65)***	0.64 (0.48-0.84)***

340

341 Table 5. Univariate and multivariate logistic regressions of predictors of **positive RDT**, Nigeria MIS
342 2015

Variable	Univariate analysis Odds Ratio (95%CI)	Multivariate analysis Odds Ratio (95%CI)
Age of respondent		
15-19	1.00	1.00
20-24	1.14 (0.97-1.35)	1.06 (0.86-1.32)
25-29	0.95 (0.80-1.12)	1.01 (0.81-1.27)
30-34	1.02 (0.86-1.21)	0.99 (0.78-1.25)
35-39	0.84 (0.69-1.01)	0.99 (0.76-1.28)
40-44	0.90 (0.73-1.11)	1.18 (0.89-1.57)
45-49	0.91 (0.69-1.18)	0.97 (0.71-1.35)
Wealth index		
Poorest	1.00	1.00
Poor	0.72 (0.61-0.84)***	0.76 (0.62-0.92)**
Middle	0.48 (0.41-0.56)***	0.68 (0.55-0.85)**
Rich	0.25 (0.21-0.30)***	0.44 (0.34-0.57)***
Richest	0.08 (0.07-0.10)***	0.15 (0.11-0.21)***
Age of child in months		
6-11	1.00	1.00
12-23	0.87 (0.70-1.07)	1.10 (0.86-1.41)
24-35	1.28 (1.04-1.57)*	1.47 (1.15-1.88)**
36-47	0.86 (0.71-1.06)	1.15 (0.91-1.47)
48-59	1.12 (0.92-1.38)	1.24 (0.97-1.58)
Child birth order		
1 st	1.00	1.00
2 nd	0.92 (0.78-1.08)	0.98 (0.80-1.22)
3 rd	1.26 (1.06-1.51)**	1.01 (0.80-1.26)
4 th and more	1.25 (1.09-1.43)***	0.86 (0.72-1.02)
Number of under fives		
None	1.00	1.00
One	0.98 (0.84-1.13)	0.98 (0.81-1.18)
Two	1.50 (1.30-1.74)***	0.98 (0.80-1.19)
Three	1.18 (0.98-1.41)	0.88 (0.69-1.13)
Four and more	2.03 (1.66-2.46)***	1.11 (0.84-1.48)
Haemoglobin level of child		
Not anaemic	1.00	1.00
Severe anaemia	2.94 (2.26-3.82)***	1.86 (1.36-2.56)***
Mild anaemia	2.49 (2.18-2.85)***	1.58 (1.34-1.86)***
Moderate anaemia	1.31 (1.12-1.53)***	1.68 (0.98-1.40)
The child slept under net last night		
No	1.00	1.00
Yes	1.42 (1.28-1.58)	1.01 (0.87-1.17)
Education		
None education	1.00	1.00
Primary	0.61 (0.53-0.70)***	0.74 (0.62-0.89)**
Secondary	0.36 (0.31-0.41)***	0.99 (0.80-1.21)
More than secondary	0.15 (0.11-0.20)***	0.79 (0.52-1.20)

Zone		
North Central	1.00	1.00
North East	0.73 (0.61-0.88)***	0.69 (0.55-0.86)**
North West	1.35 (1.17-1.57)***	1.12 (0.90-1.39)
South East	0.45 (0.36-0.56)***	1.08 (0.82-1.43)
South-South	0.40 (0.32-0.49)***	0.71 (0.55-0.92)**
South West	0.46 (0.39-0.55)***	1.26 (0.98-1.62)
Residence		
Urban	1.00	1.00
Rural	3.96 (3.52-4.46)***	1.95 (1.62-2.33)***
The household has at least one net		
No	1.00	1.00
Yes	1.16 (1.04-1.30)**	1.01 (0.87-1.17)
Household sprayed with IRS		
No	1.00	1.00
Yes	0.21 (0.12-0.38)***	0.20 (0.07-0.57)**
Knowledge of malaria cause		
No	1.00	1.00
Yes	0.62 (0.53-0.72)***	1.18 (0.86-1.61)
Knowledge of malaria prevention		
No	1.00	1.00
Yes	0.62 (0.55-0.71)***	0.78 (0.60-1.01)

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