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*Full Length Research Paper*

# Prevalence of malaria and anaemia during the dry season in North Central and South Western Nigeria

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**Malariometric surveys provide information on epidemiological parameters used in assessing malaria burden for evidence-based decision making. This study provides information on some malariometric indices in two ecologically distinct areas in Nigeria. The study was conducted in New Bussa in Niger State (Sudan savannah) and Ijede in Lagos State (tropical rain forest). Study participants were screened for malaria, fever, anemia and their demographic characteristics recorded. A total of 1,648 participants (813 from New Bussa and 835 from Ijede) were recruited. Majority of the participants in New Bussa were in age group of 5-15 years, (39.9%) while in Ijede they were in age group >35 years, 68.6%. Overall, malaria prevalence by mRDT was 19.4% (95% CI: 17.4-21.5) while microscopy was 11.9% (95% CI: 10.3-13.6). Malaria prevalence in New Bussa by mRDT and microscopy were 32.5% (95% CI: 28.8-36.4) and 18.8% (95% CI: 16 -21.9) respectively while in Ijede malaria prevalence by mRDT was 9.6% (95% CI: 9.7-11.9) and microscopy was 5.7% (95% CI: 4.2 -7.7) respectively. Malaria prevalence was higher in children within 5–15 years of age than other age groups (P<0.05). Fever rate reduced with age and malaria was more prevalent in participants with fever than those without fever (P<0.01). Anaemia prevalence in the two study sites were similar, 21.5%. (P = 0.28). Malaria was hypoendemic and mesoendemic in Ijede and New Bussa respectively during the dry season. There was association between malaria and fever. However, malaria was not a major cause of fever.**

**Key words:** Malaria, fever, anaemia, prevalence, endemicity, Nigeria.

## INTRODUCTION

Significant progress has been made in curtailing the menace of malaria since the launching of Roll Back Malaria in the year 2000 (WHO, 2017), yet the disease continues to receive attention as a public health issue. The latest estimates report that 3.2 billion people are at the risk of being infected globally while 212 million malaria cases and 429,000 deaths occurred in year 2015 (WHO, 2017). As at 2010, 85% of Nigerians lived in

areas supporting mesoendemic transmission, 15% lived under conditions of hyper- to holo-endemicity with some areas showing hypo-endemicity (Federal Ministry of Health, 2014). Of the 91 countries that have on-going transmission of malaria, Nigeria contributed 29% of total malaria cases in 2015 (WHO, 2017). Thus, Nigeria has a potential to contribute substantially to the global efforts at eradicating malaria.

Seasonal variation has been known to affect malaria transmission such that there is an increase in malaria transmission in the rainy season compared to wet season. This is mainly due to increase in breeding sites of mosquitoes in the rainy season translating to increased mosquito density and therefore increase malaria infection rate (Midekisa et al., 2015; Reiner et al., 2015). Conversely, in the dry season, there is a reduction in malaria transmission and therefore reduction in malaria prevalence.

Although the causes for anaemia are multifactorial, parasite diseases such as malaria and helminths have been linked to anaemia in children living in malaria-endemic areas (Athuman et al., 2007; WHO, 2011). Similar seasonal patterns have been observed in malaria and anaemia and cases of anaemia increase when malaria cases increase (Koram et al., 2003; Okebe et al., 2016).

The major mechanisms are those of red cell destruction and decreased red cell production (Phillips and Pasvol, 1992). Potential causes of haemolysis include loss of infected cells by rupture or phagocytosis, removal of uninfected cells due to antibody sensitization or other physicochemical membrane changes, and increased reticuloendothelial activity, particularly in organs such as the spleen (Phillips and Pasvol, 1992). Analysis of anemia prevalence and status is therefore a relevant indices of malaria epidemiology.

Most of the current interventions including use of long-lasting insecticidal nets (LLIN) and artemisinin-based combination therapy (ACTs) have resulted in reduction of the malaria burden. However, reliable data on progress made in reducing malaria burden are not exhaustive. Up to date, information will be required as malaria landscape changes to determine appropriate interventions needed. Therefore it is necessary to determine baseline malariometric information of communities that will serve as models for intervention studies. Malariometric survey can provide time-point and seasonal information on parasitological and entomological indices, pattern of drug use and efficacy, socio-behavioural and economic determinants of malaria incidence, prevalence and endemicity in defined geographical locations. This study provides information on parasitological aspect of malariometric characterization of two ecologically distinct sites in Nigeria.

## METHODOLOGY

### Study sites

This cross-sectional study was carried out in the dry season, January 2014, in New Bussa (N09° 54.476', E004° 33.876'), Borgu LGA, Niger State and Ijede (N06° 34.076 E003° 35.637'), Ikorodu LGA, Lagos State. New Bussa has an average elevation of 171 m above sea level. It is sparsely populated with 14 people per $km^2$, small settlements separated by short distances. New Bussa has a dry sub-humid climate which is classified as a Sudan savannah and landscape mostly covered with closed to open shrub land. The hottest period in the year is in March with an average temperature of 37.9°C at noon, preceding the rains in April. The coldest temperatures are experienced in December with an average temperature of 16°C at night. Annual average rainfall is 1010 ± 180 mm, while humidity averages 80% in the year. Rainfall and other precipitations peak in May/June and August/September. The time around November is driest. The four rural communities studied in New Bussa including Tada, Monai, Masana, and Yuna are serviced by a primary health post located in Tada. There is a public primary school and a secondary health facility located in New Bussa which serves a population of 234,718 people, the estimated population of New Bussa in 2014 (Projections from 2006 Census). The people of New Bussa speak varieties of Mandig language, Boko bussa, Baatcnum, Boo Bussa, Boko Baru, Dendi, Fulfulde, Yoruba, and Hausa. They are mostly fishermen, farmers and petty traders. The schools, churches and big shops are located in the main town away from easy reach of the villagers who commute on dirt roads by the occasional vehicle, but mostly on bikes and on foot.

Ijede has an average elevation of 42 m above sea level. The area is very densely populated with 6,174 people per $km^2$. Ijede has a secondary forest vegetation of mostly broadleaved evergreen or semi-decidious forest, with swampy areas. It also has two peaks of rainfall in June and September with mean annual rainfall of about 1900 ± 250 mm and humidity averaging 77%. March is warmest with an average temperature of 32.4°C at noon. August is coldest with an average temperature of 22.6°C at night. The time around January is driest. Ijede is categorized as semi urban by the Ikorodu Local Government Area to which it belongs in Lagos State. It is one of the five Local Government Development Council Areas (LCDA) of Ikorodu and lies about 36 km North East of Lagos State, a coastal community with veritable undulating lowland, its population was put at 133,317 in 2014 (Projections from 2006 Census). The locals are Ijebu Yorubas and are mostly petty traders with fishermen and a few farmers. Ijede has a public primary and two public secondary schools. There are several private primary and secondary schools, with well served electricity by a 1320MV Egbin thermal station, the biggest in West Africa just next to the community.

### Field study

All study participants were screened for fever (axillary temperature≥ 37.5°C), malaria by microscopy (WHO, 2010) and malaria rapid

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**Table 1.** Demographic characteristics of study participants.

| Characteristic | Ijede [n (%)] | New Bussa [n (%)] | Total | P |
|---|---|---|---|---|
| **Number of participants** | 813 | 835 | 1648 | |
| **Sex** | | | | |
| Male | 257 (31.6) | 433 (51.9) | 690 | <0.001 |
| Female | 556 (68.4) | 402 (48.1) | 958 | |
| **Age (years)** | | | | |
| Median (range) | 30 (0.42-100) | 12 (0.4-90) | 20 (0.4-100) | <0.001 |
| **Age group** | | | | |
| <5 | 134 (16.5) | 143 (17.1) | 277 (16.8) | <0.001 |
| 5-15 | 108 (13.3) | 333 (39.9) | 441 (26.8) | |
| 16-35 | 244 (30) | 209 (25) | 453 (27.5) | |
| >35 | 327 (68.6) | 150 (18) | 477 (28.9) | |
| **Weight (kg)** | | | | |
| Median (range) | 59 (5-124) | 33 (5-97) | 48 (5-124) | <0.001 |
| **Height (m)** | | | | |
| Median (range) | 1.67 (0.6-1.95) | 1.43 (0.57-1.87) | 1.55 (0.57-1.95) | <0.001 |
| **Temperature (°C)** | | | | |
| Mean±SD | 36.6±0.6 | 36.9±0.5 | 36.7±0.6 | <0.001 |
| ≥37.5 | 32 (3.9) | 84 (10.1) | 116 (7.1) | <0.001 |
| <37.5 | 779 (96.1) | 750 (89.9) | 1529 (92.9) | |

n: Number of participants; %: percentage; P: Probability value; SD: Standard deviation.

diagnosis test (mRDT) using Carestart™ (Access Bio Inc., USA). All persons diagnosed to have malaria were treated with artemether-lumefantrine. Blood spots were made on filter paper for molecular studies on malaria parasite characteristics such as level of resistance to various antimalarial drugs (findings to be published elsewhere). Anaemia status of the participants were defined using the WHO haematocrit cut-off for mild, moderate and severe anaemia based on age and sex (WHO, 2011). Demographic information of the participants was also recorded.

### Data analysis

Malaria endemicity was classified based on prevalence of malaria in children between the ages of 2 and 9 years (Metselaar and Van Theil, 1959). In this method, an area with a malaria prevalence in 2 to 9 years old children <10% is hypoendemic, 11 to 50% is mesoendemic, 51 to 75% is hyperendemic, while >75% is holoendemic. Data were analyzed using SPSS 20.0 for Windows. Variables considered in the analysis were related to the presence and densities of malaria parasites, fever, anemia and participants demographics. Proportions were compared by calculating Chi-square, Fisher's exact or Mantel Haenszel tests as appropriate. Normally distributed, continuous data were compared by t test and analysis of variance. Data not conforming to a normal distribution were compared by the Mann-Whitney U tests and the Kruskal Wallis tests (or by Wilcoxon ranked sum test). P values less than 0.05 were considered statistically significant.

### Ethical consideration

The study protocol was approved by the Institutional Review Board of Nigerian Institute of Medical Research, Yaba, Nigeria. Local permissions to conduct the study were obtained from community heads, while individuals gave written informed consent before participating in the study.

## RESULTS

A total of 1,648 participants were recruited into the study (813 from New Bussa and 835 from Ijede). The demographic characteristics in the two study sites were different, more males were seen in New Bussa, 433 (51.9%) than in Ijede, 257 (31.6%). The median ages of participants were 12 and 30 years in New Bussa and Ijede, respectively. Majority of the participants in New Bussa were in the age group 5 to 15 years, 333 (39.9%) while in Ijede they were in the age group >35 years, 327 (68.6%). The median height and weight of participants in New Bussa were 1.4 m and 30.6 kg, while in Ijede they were 1.7 m and 59 kg, respectively. About 10% of the study participants were febrile in New Bussa, while less than 4% in Ijede were febrile (Table 1).

**Table 2.** Malaria indicators in Ijede and New Bussa sites.

| Characteristic | Ijede [n (%)] | New Bussa [n (%)] | Total | P |
|---|---|---|---|---|
| **Malaria** | | | | |
| Prevalence (mRDT) | 78 (9.6) | 197 (32.5) | 275 (19.4) | |
| 95% CI | 7.7-11.9 | 28.8-36.4 | 17.42-21.53 | <0.001 |
| Prevalence (microscopy) | 43 (5.7) | 129 (18.8) | 172 (11.9) | |
| 95% CI | 4.2-7.7 | 16-21.9 | 10.33-13.6 | |
| **Plasmodium species** | | | | |
| *P. falciparum* | 39 (90.7) | 118 (91.5) | 157 (91.3) | |
| *P. malariae* | 0 | 4 (3.1) | 4 (2.3) | |
| *P. ovale* | 1 (2.3) | 1 (0.8) | 2 (1.2) | <0.001 |
| *P. falciparum+ P. malaraie* | 3 (7.0) | 4 (3.1) | 7 (4.1) | |
| *P. falciparum + P. ovale* | 0 | 2 (1.6) | 2 (1.2) | |
| **Parasite density/µl blood** | | | | |
| Geometric mean (Range) | 277 (34-50833) | 342 (28-30891) | 325 (28-50833) | 0.180 |
| **Parasite density groups** | | | | |
| 1-500 | 28 (66.7) | 80 (64.5) | 108 (65.1) | |
| 501-1000 | 6 (14.3) | 19 (15.3) | 25 (15.1) | 0.968 |
| >1,000 | 8 (19.0) | 25 (20.2) | 33 (19.9) | |
| **Axillary temperature (°C)** | | | | |
| Mean±SD | 36.6±0.6 | 36.9±0.5 | 36.7±0.6 | 0.935 |
| Range | 35-40 | 35.6-40.5 | 35-40.5 | |
| ≥37.5 | 32 (3.9) | 84 (10.1) | 416 (7.1) | <0.001 |
| <37.5 | 779 (96.1) | 750 (89.9) | 1529 (92.9) | |
| **PCV (%)** | | | | |
| Mean±SD | 39.3±6.0 | 38.4±5.2 | 38.9±5.6 | <0.001 |
| Range | 15 - 55 | 13 - 53 | 13 - 55 | |
| Normal PCV | 593 (79) | 517 (77.9) | 1110 (78.5) | |
| Mild Anaemia | 71 (9.5) | 78 (11.7) | 149 (10.6) | 0.28 |
| Moderate anemia | 72 (9.6) | 62 (9.3) | 134 (9.5) | |
| Severe anaemia | 15 (2) | 7 (1.1) | 22 (1.5) | |

Anaemia was determined according to WHO classification for different categories*. n: Number of participants; %: percentage; P: Probability value; SD: Standard deviation.

Overall, malaria positivity rate was 19.4% (95% CI: 17.4-21.5) and 11.9% (95% CI: 10.3-13.7) by mRDT and microscopy, respectively. Malaria prevalence in New Bussa by mRDT and microscopy were 32.5% (95% CI: 28.8-36.4) and 18.8% (95% CI: 16-21.9), respectively while in Ijede malaria prevalence by mRDT and microscopy were 9.6% (95% CI: 9.7-11.9%) and 5.7% (95% CI: 4.2-7.7), respectively. *Plasmodium falciparum* was the predominant species in both sites with prevalence of over 95%. Other species (*Plasmodium malariae* and *Plasmodium ovale*) were also seen either as mono infection or mixed infection with *P. falciparum.* Geometric mean parasite density in the two sites were similar [New Bussa, 342 Parasite/µl of blood; Ijede, 277 parasite/µl of blood; P=0.18]. Fever rate was higher in New Bussa (10.1%) compared to Ijede (3.9%). The mean packed cell volume of the study participants in New Bussa (38.4±5.2%) was significantly lower than in Ijede (39.3±6.0%). However, the proportions of study participants with mild, moderate or severe anemia were similar in both sites (P=0.28) (Table 2).

Overall, malaria positivity by mRDT and microscopy was associated with fever (P<0.01). However, in the individual sites this was not the case (P>0.05) though the proportion of malaria positive cases were higher in persons with fever than in those without fever. In Ijede,

**Table 3.** Comparison of fever rate and malaria positivity by MRDT and microscopy in the study sites.

| Character | Ijede | | New Bussa | | Overall | |
|---|---|---|---|---|---|---|
| | mRDT (%) | Microscopy (%) | mRDT (%) | Microscopy (%) | mRDT (%) | Microscopy (%) |
| Temperature (°C) | | | | | | |
| <37.5 | 74/779 (9.5) | 39/722 (5.4) | 170/545 (31.2) | 112/617 (18.2) | 244/1324 (18.4) | 148/1339(11.0) |
| ≥37.5 | 4/32 (12.5) | 4/31 (12.9) | 26/60 (43.3) | 17/69 (24.6) | 30/92 (32.6%) | 21/100 (21.0) |
| Total | 78/811 (9.6) | 43/753 (5.7) | 196/605 (32.4) | 129/686 (18.8%) | 274/1416 (19.4) | 169/1439 (11.7) |
| P | 0.371 | 0.094 | 0.056 | 0.191 | **0.0008** | **0.003** |

MRDT: Malaria rapid diagnostic test; P: Probability value.

**Table 4.** Malaria positivity according to age groups and sex in Ijede and New Bussa.

| Age (years) | mMRDT | | | Microscopy | | |
|---|---|---|---|---|---|---|
| | Ijede [n/N (%)] | New Bussa [n/N (%)] | P | Ijede [n/N (%)] | New Bussa [n/N (%)] | P |
| <5 | 14/134 (10.4) | 25/105 (23.8) | 0.001 | 4/126 (3.2) | 21/107 (19.6) | <0.001 |
| 5-15 | 23/108 (21.3) | 119/236 (50.4) | <0.001 | 13/102 (12.7) | 65/275 (23.6) | 0.020 |
| 16-35 | 15/244 (6.1) | 36/156 (23.1) | <0.001 | 12/224 (5.4) | 24/168 (14.3) | 0.002 |
| >35 | 26/327 (8.0) | 17/109 (8.6) | 0.02 | 14/303 (4.6) | 19/137 (13.9) | 0.001 |
| P | 0.0001 | <0.0001 | | 0.0088 | 0.0336 | |
| **Endemicity** | | | | | | |
| Prevalence in children 2-9 years | 27/148 (18.2) | 85/223 (38.1) | | 10/131 (7.1) | 56/249 (22.5) | |
| 95%CI | 12.9-25.2 | 32.0-44.6 | <0.001 | 3.9-12.6 | 17.7-28.1 | <0.001 |
| Classification | Mesoendemic | Mesoendemic | | Hypoendemic | Mesoendemic | |
| **Gender** | | | | | | |
| Male | 30/257 (11.7) | 117/314 (37.3) | <0.001 | 13/247 (5.3) | 73/367 (19.9) | <0.001 |
| Female | 48/556 (8.6) | 80/292 (27.4) | <0.001 | 30/508 (5.9) | 56/320 (17.5) | <0.001 |
| P | 0.171 | 0.01 | | 0.721 | 0.423 | - |

MRDT: Malaria rapid diagnostic test; P: Probability value; CI: Confidence interval.

malaria positivity by mRDT in persons with and without fever were 4 of 32 (12.5%) and 74 of 779 (9.5%) while in New Bussa it was 26 of 60 (43.3%) and 170 of 545 (31.2%), respectively. In Ijede, malaria positivity by microscopy in persons with and without fever were 4 of 3 (12.9%) and 39 of 722 (5.4%), while in New Bussa it was 17 of 69 (24.6%) and 112 of 617 (18.2%), respectively (Table 3). Study participants in the age group 5 to 15 years had significantly higher malaria positivity rate than other age group in both study sites irrespective of the diagnostic method used. Gender was not associated with malaria positivity except in New Bussa using mRDT, where the males had higher malaria positivity rate of 117 (37.3%) and females 80 (27.4%) (P=0.01). Malaria prevalence rate in children aged 2 to 9 years, which is used for the classification of malaria endemicity (Metselaar and Van Theil, 1959; Metselaar and Van Theil, 1959) was 7.1% in Ijede and 22.5% in New Bussa based on microscopy result. This is an indication that malaria is hypodemic in Ijede and mesoendemic in New Bussa in the dry season (Table 4).

Fever among study participants with malaria decreased with age, the higher the age the lower the fever rate among malaria positive participants (Figure 1). Malaria contributed more to fever rate in New Bussa than in Ijede. The difference was greatest in 15 years and below in 16 years and above (Figure 2). Malaria cases with fever in children under 5 years were lower in Ijede than in New Bussa. However, the reverse was the case in above 5 years in both sites (Figure 3).

*P. falciparum* species was the only species observed in children under 5 years in both study sites, while other species were observed in participants above 5 years (Figure 4). *Plasmodium falciparum* species was the only species observed in children under 5 years in both study sites while other species were observed in participants above 5 years (Figure 5).

Overall, there was a significant decline in the

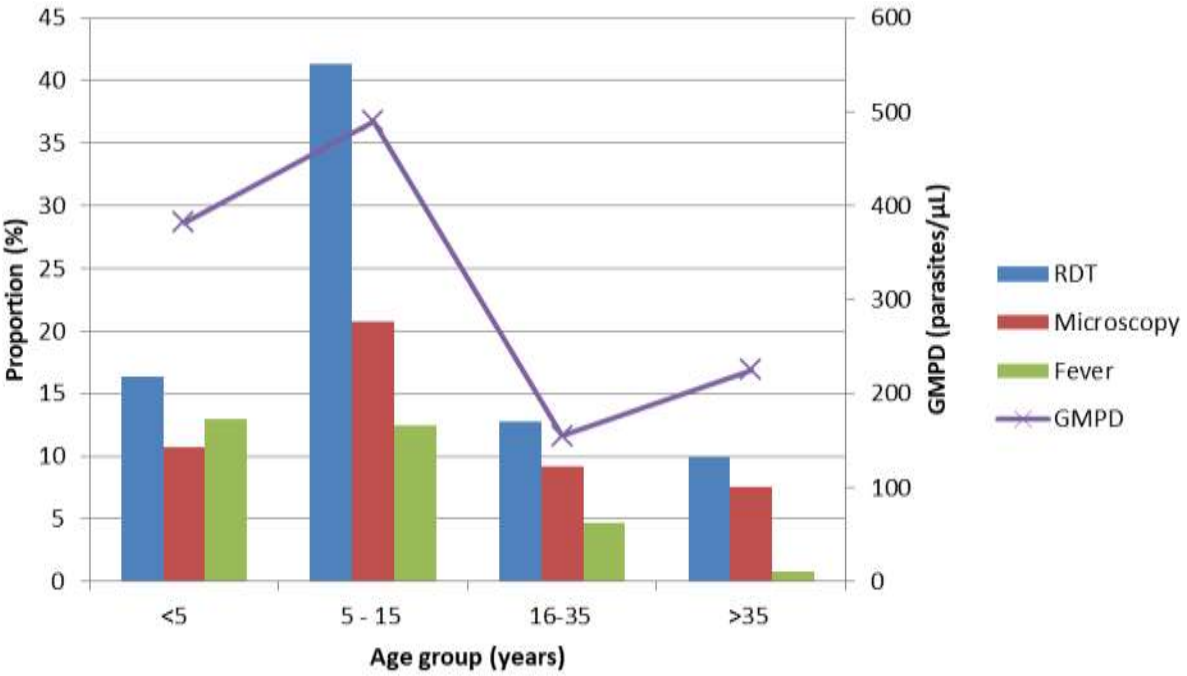


**Figure 1.** Prevalence Distribution of persons with fever, prevalence of malaria and parasitemia amongst the malaria positive study participants in different age groups.

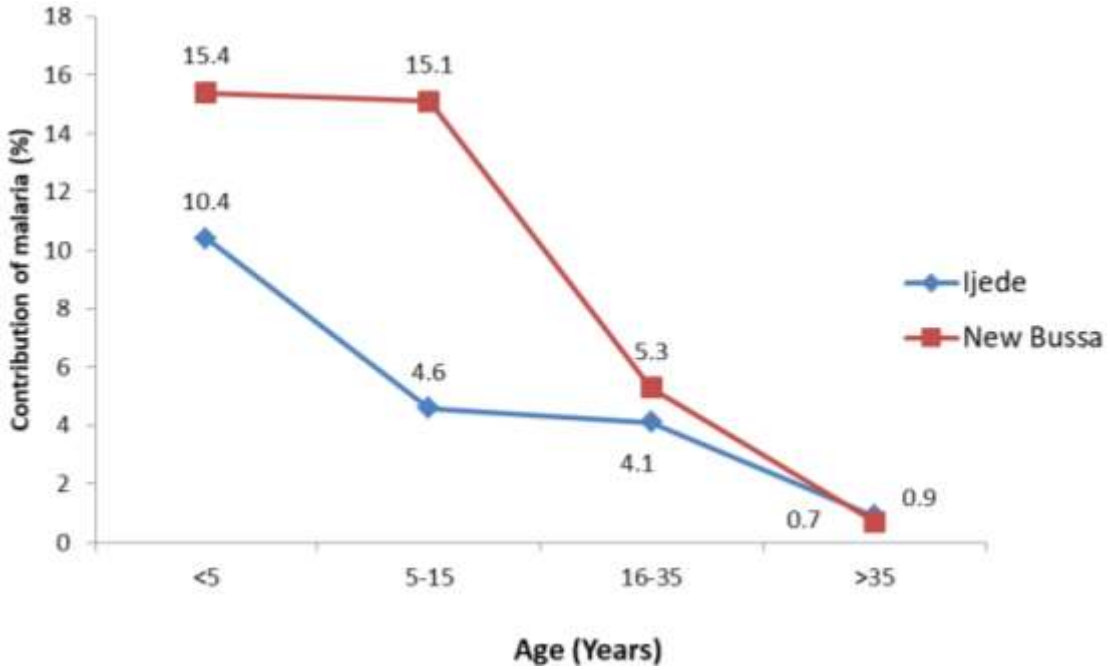


**Figure 2.** Contribution of malaria to fever by age in the two study sites.

prevalence of anaemia as age increased (P = 0.036) withchildren less than 5 years having the highest prevalence of anaemia (30.5%). This trend was observed in both sites but the decline was not statistically significant in either Ijede (P=0.704) or New Bussa (P=0.085). Comparison of proportion of children with anaemia in the different age groups showed that specific age groups had similar anaemia rates (P>0.05). There was no association between anaemia and gender either overall or in any of the two sites (P>0.05) (Table 5).

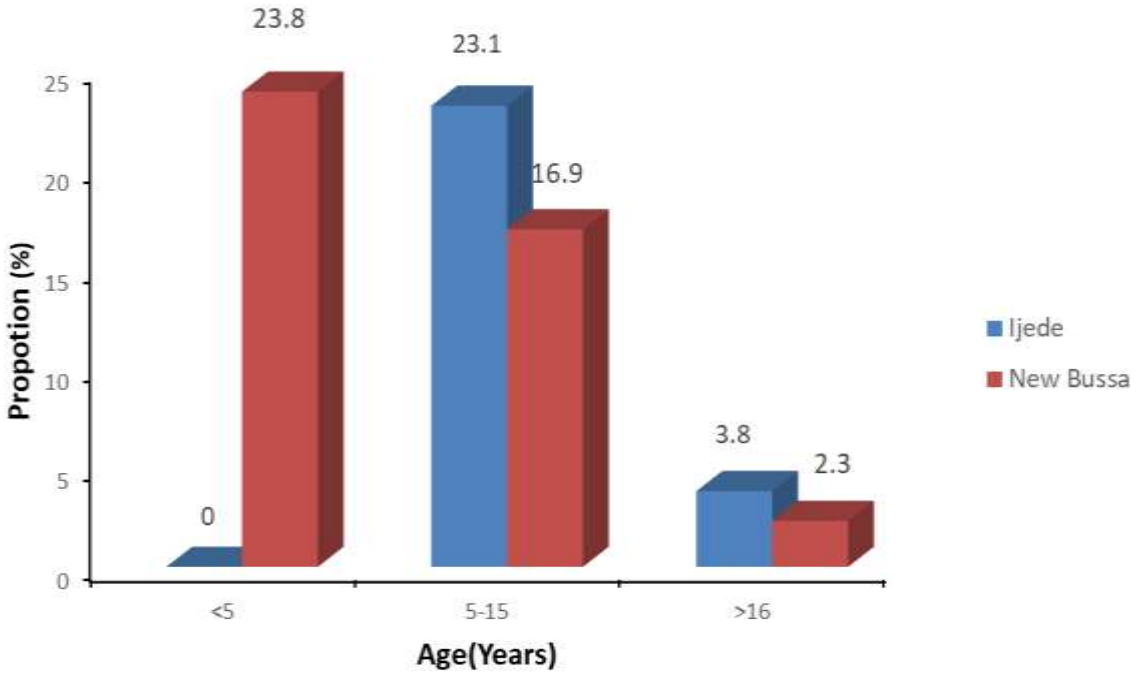


**Figure 3.** Malaria cases with fever.

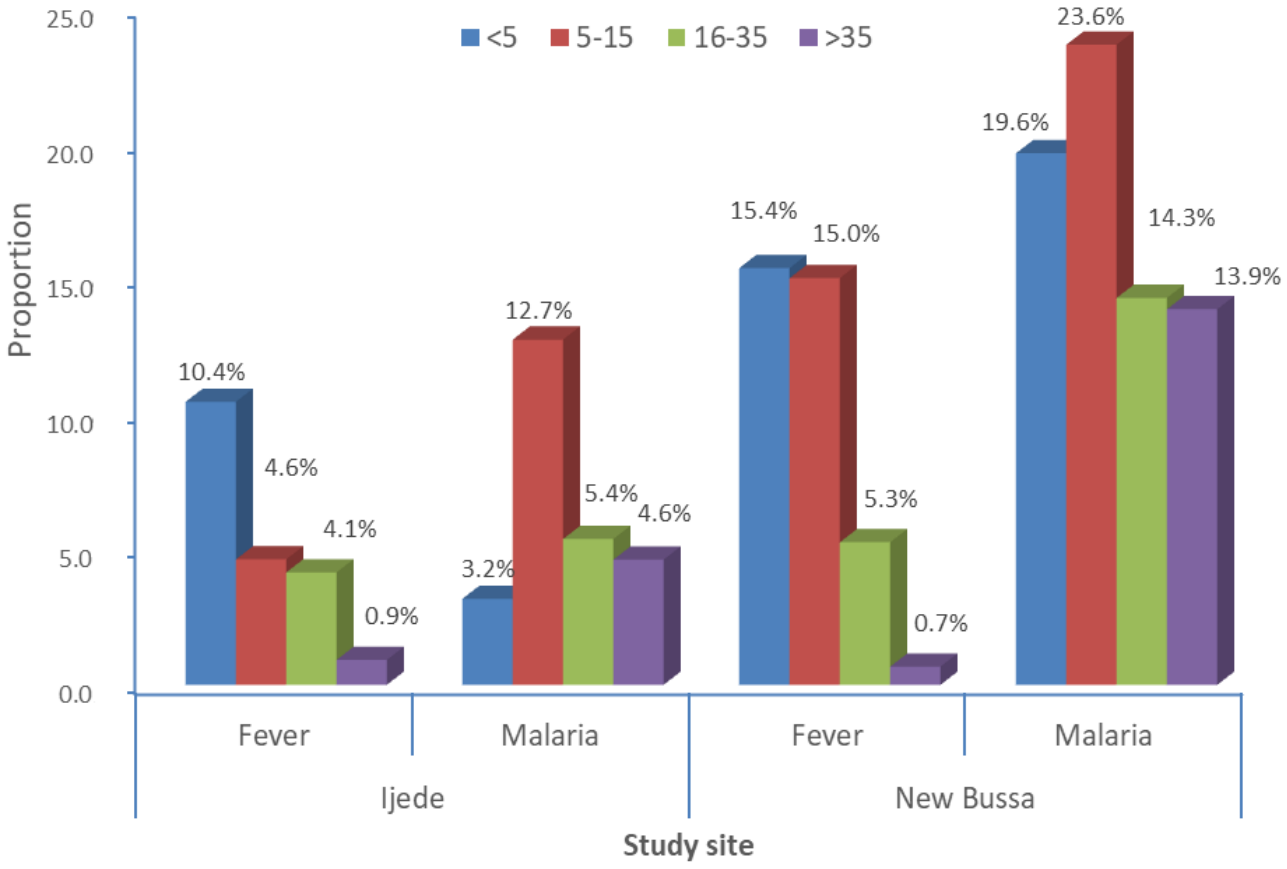


**Figure 4.** Prevalence of malaria and fever by age group.

**Table 5.** Prevalence of anaemia by age and gender in the two study sites.

| Parameter | Anaemia | | | |
|---|---|---|---|---|
| | Ijede | New Bussa | ALL | P |
| **Age** | | | | |
| <5 | 18/68 (26.5) | 21/60 (35.0) | 39/128 (30.5) | 0.295 |
| 5-15 | 15/62 (24.2) | 44/144 (30.6) | 59/206 (28.6) | 0.354 |
| 16-35 | 29/135 (21.5) | 24/90 (26.7) | 53/225 (23.6) | 0.369 |
| >35 | 36/180 (20.0) | 12/72 (16.7) | 48/252 (19.0) | 0.542 |
| Total | 98/445 (22.0) | 101/366 (27.6) | 199/811 (24.5) | 0.664 |
| P | 0.704 | 0.085 | 0.036 | - |
| **Gender** | | | | |
| F | 61/308 (19.8) | 52/186 (28.0) | 113/494 (22.9%) | 0.037 |
| M | 38/138 (27.5) | 49/180 (27.2) | 87/318 (27.4) | 0.95 |
| Total | 99/446 (22.2) | 101/366 (27.6) | 200/812 (24.6) | 0.076 |
| P | 0.069 | 0.875 | 0.148 | - |

P: Probability value.

*P. falciparum* was the only species observed in the age group of <5 and >35 years. Mononfection of each of the three plasmodium species and co-infection of *P. ovale* and *P. malariae* with *P. falciparum* was observed in age group 5 to 15, while age group 16 to 35 years had *P. malariae* and *P. falciparum* species infections

## DISCUSSION

The difference in the demographic characteristics in the two sites especially having more males in New Bussa than in Ijede was likely due to the limited access to females due to religious reasons in some of the communities in New Bussa that were predominantly muslims. This study reports a lower prevalence of malaria in the South Western than in the North Central part of Nigeria. Similar findings have been reported by other workers showing that prevalence of malaria has been consistently higher in the Northern than Southern parts of Nigeria (Dawaki et al., 2016; Umaru and Uyaiabasi, 2015; Oguche et al., 2014). In the study by Oguche et al. (2014), the hospital prevalence of malaria was 25% in Lagos (South west) and in Barkin Ladi (North Central) it was 38%. The two sites in our study are close to large water bodies, River Niger in New Bussa and Lagos lagoon in Ijede, thus providing sufficient breeding ground for mosquitoes. The difference in prevalence could be attributed to the implementation of malaria control programme in Lagos State since 2010, starting with free diagnosis and malaria treatment programme in public health facilities, household distribution of LLINS to Indoor Residual Spray (IRS) of houses while this integrated malaria control interventions are low in Niger State. Furthermore, the living conditions in New Bussa are poorer and more conducive with transmission than in Ijede.

Malaria was hypodemic in Ijede but mesoendemic in New Bussa in the dry season based on malaria microscopy assessment in 2 to 9 year-old children. This is the first report showing that malaria drops to hypoendemic levels in Lagos during dry seasons. This is an indication that malaria burden in Lagos State is declining. A previous study carried out earlier in Lagos in a location close to and with similar environmental characteristics to the present study site reported malaria to be mesoendemic in the dry season (Aina et al., 2013). The mesoendemicity of malaria in New Bussa reported in this study is similar to previous reports in the region (Federal Ministry of Health, 2016; Adedoja et al., 2015).

The trend in malaria positivity rate (irrespectively of diagnostic method) and level of parasitaemia in the different age groups was similar in the two study sites, with age range 5 to 15 years having the highest prevalence and geometric mean parasite density. Our finding that children above 5 years are more at risk of malaria infection than under 5 year olds, has also been reported by other workers (Aina et al., 2013; Oladosu and Oyibo, 2013; Mawili-Mboumba et al., 2013; Umaru and Uyaiabasi, 2015; Ceesay et al., 2008). However, Nmadu et al. (2015) reported the highest prevalence of malaria in children between 2 to 5 years of age in a General Hospital in Abuja. The lower parasite rate in under 5-year olds than older children may be attributed to the impact of previous malaria interventions in Nigeria which focused on the protection of under 5-year olds and pregnant women at the time of the study (NPC, 2012). Currently, malaria intervention activities in Nigeria are targeted at all persons irrespective of level of susceptibility to malaria, while in a more distant past year 2005, efforts at renewed

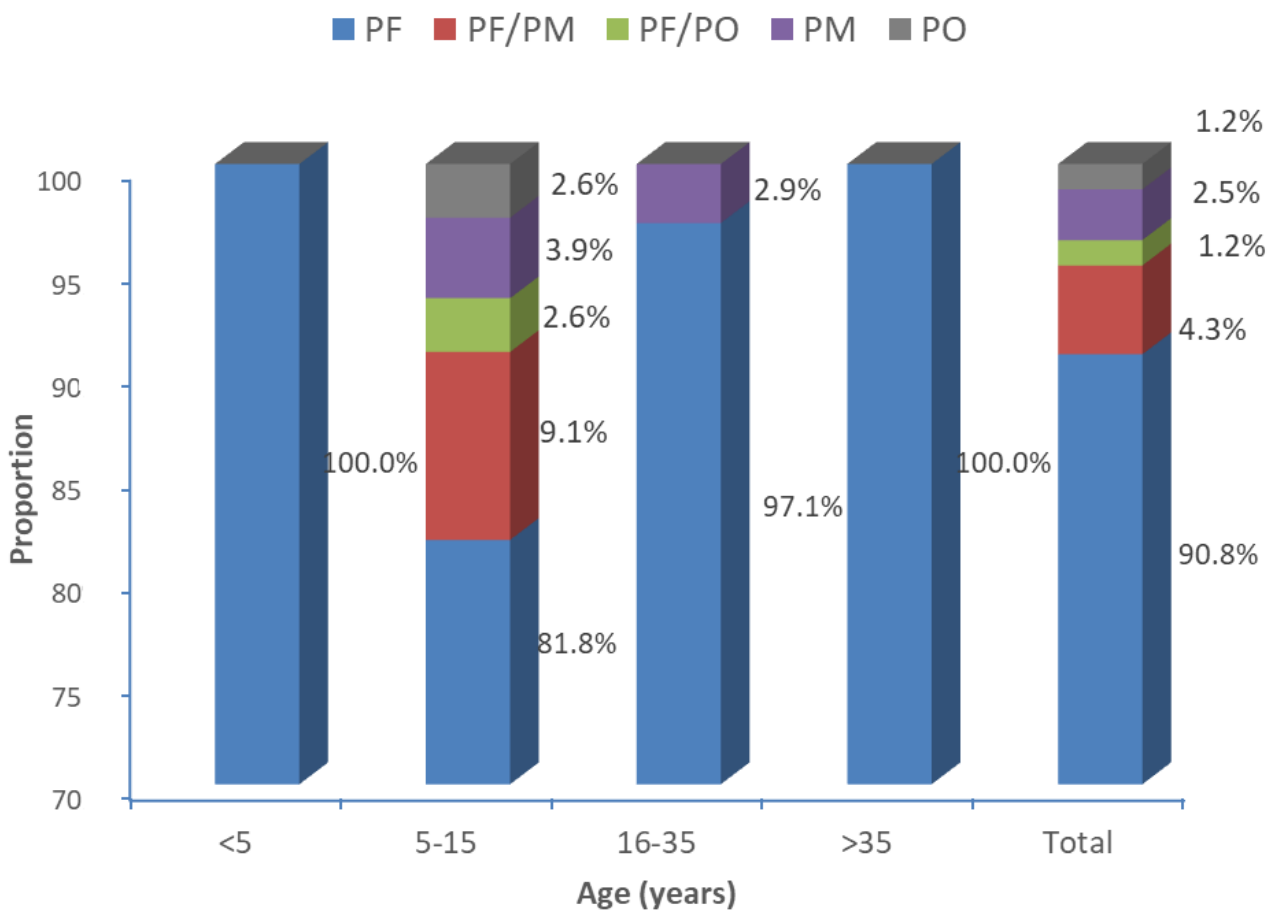


**Figure 5.** Plasmodium species distribution by age.

malaria control were effected through policy change in the drug of choice for treatment of malaria from the ineffective chloroquine and sulfadoxine pyrimethamine to Artemisinin Combination Therapies (Federal Ministry of Health, FMH 2005). Gains have accrued in an estimated20 to 40% decrease in malaria incidence and mortality rates between 2010 and 2015 (WHO, 2017) but the factors responsible for these gains are not all known (NMCP, suMAP and Project, 2013). It is apparent that there is delay in the acquisition of immunity to *P. falciparum* because children encounter the disease much latter and less frequently, a quality that describes pattern of malaria burden in meso-endemic regions as compared with situations when malaria transmission was hyper and holoendemic (Molineaux and Gramiccia, 1980; Carter and Mendis, 2002; Doolan et al., 2009). On the other hand, progressive decline in fever rate as age increased is a natural consequence of repeated exposure to infectious diseases, as age increases (Ladeia-Andrade et al., 2009).

The *Plasmodium* species distribution is similar in both study sites with *P. falciparum* having prevalence of over 95% (either as mono or mixed infection). It was noted that children under the age of five had only *P. falciparum* (100%) in both study sites unlike older age group where other *Plasmodium* species were observed albeit at very low levels. This is in agreement with studies by Sitali et al. (2015), but contrary to observation of inverse correlation of age with mixed infection by (Guerra-Neira et al., 2006). It may be attributed to the low immunity in the under 5 years and the high virulence of *P. falciparum* such that once the children under 5 are infected with *P. falciparum* it results quickly in acute malaria cases. However, in children above 5, their anti-disease immunity allows asymptomatic carriage of *P. falciparum* infection, thereby providing opportunity for multiple infections with malaria parasite species. This is the first report documenting different species in different age groups in the study sites.

The prevalence of anaemia was similar in both sites and there was no association between anaemia and malaria positivity unlike observed in a near-universal LLIN coverage study in Zambia which showed a strong positive correlation between the prevalence of malaria parasite infection and severe anemia. The predominantly low parasitaemia (1-500 parasite/µl of blood) was not

sufficient to cause a significant difference in anaemia levels [Anaemia prevalence: New Bussa 22%; Ijede 21%]. Although, the mean packed cell volume (PCV) values were significantly different, the relatively wide band width for normal PCV (approximately 17 points) (WHO, 2011) may have accounted for the similarity in anaemia levels in both sites. The lower mean PCV observed in New Bussa than in Ijede may be attributed to the higher parasite prevalence in New Bussa. The study did not assess other causes of anaemia apart from malaria.

## CONCLUSION

The level of endemicity of malaria was different in both study sites, hypoendemic in Ijede and mesoendemic in New Bussa, during the dry season. Malaria prevalence was lower in children less than five years than in above 5-year old children. Fever rate reduced as age increased. However, malaria was not a major cause of fever in the two study sites. Anaemia prevalence was similar in both sites and was not associated with malaria.

## RECOMMENDATION

Community based malaria study should not be based on fever rather it should be based on screening for malaria parasite. Malaria control intervention should be deployed to everyone and not only children under 5 years of age and pregnant women.

## CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

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