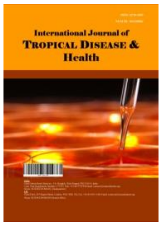


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# The Burden and Socio-demographic Differentials of Malaria Infection among Asymptomatic School Children in Gombe State, Nigeria

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***Authors' contributions***

*This work was carried out in collaboration among all authors. The article was part of author MD's thesis work. It was supervised by author SOA as the main supervisor and author HOS as co-supervisor. Author MD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SOA and HOS managed the analyses of the study, corrected the manuscripts and managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** As a foremost disease of public health significance, malaria has wrecked untold havoc among children and pregnant women in developing countries with Africa and Nigeria being worst affected.

**Objective:** This study was aimed at documenting the prevalence and socio-demographic differences in the pattern of malaria infection among asymptomatic primary school children in Gombe state, Nigeria.

**Methodology:** Using a cross sectional study design 745 pupils aged 6 to 15 years were assessed from March to June 2019. The subjects were selected from 12 public and 6 private schools in 6

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Local Government Areas (LGAs) of the state, using multi-stage sampling technique. Malaria rapid diagnostic test (mRDT) kits were deployed in screening the subjects for malaria parasites positivity or otherwise. Data was analyzed using IBM SPSS version 21 analytical software. And the findings were presented in tables and charts. Proportions were compared using chi square, with alpha significance level set at 0.05.

**Results:** The mean age of the participants was 9.96±2.26 and 379 (50.9%) of them were boys while the rest 366 (49.1%) were girls (about 1:1 male-female sex ratio). A total of 101 (13.6%) of the 745 school children screened yielded positive to malaria rapid diagnostic test (mRDT), with children from the public primary schools being significantly (p=0.000) more affected than their counterparts in the private schools (18.2% vs. 4.1%). Though male children were more affected by malaria, the difference was not statistically significant (15.0% vs. 12.0%, P=0.229). Similarly, significantly higher proportion (p=0.000) of pupils from the rural schools were affected and were about three times more at risk of malaria (OR=3.362, CI: 2.169-5.212) than their urban counterparts (22.4% vs. 7.9%). Low academic performance was found to be associated with malaria infection (p=0.012). Other socio-demographic factors associated with malaria infection among the pupils include; senatorial district, family size, source of parental care, tribe etc. However, from the evidence of this study there was no significant association between the prevalence of malaria infection and birth order, age group and gender of the school children.

**Conclusion:** In view of the high and disproportionate distribution of the burden of malaria among the subjects, it is hereby recommended that concerned authorities should include primary schools in the design and implementation of malaria control/ elimination programmes.

*Keywords: Prevalence; malaria; school children; socio-demographic; factors.*

## 1. INTRODUCTION

Malaria is considered to be one of the foremost public health diseases that is endemic in most tropical and sub-tropical regions of the world [1, 2]. In 2018, there was an estimated 228 million cases and 405, 000 deaths of malaria globally with 213 million (93%) of such cases and 94% of such deaths coming from the World Health Organization (WHO) African Region [1]. Within the same reporting period, Nigeria alone was said to have been responsible for 25% of the global burden of the disease. As an infectious disease with high mortality rate, malaria has continued to have devastating consequences among infants, pregnant women and primary school age children in the Sub-Saharan Africa (SSA), especially in Nigeria [2]. Some of these include; school absenteeism, reduced daily output and productivity, paediatric morbidity and hospitalizations.

Malaria is transmitted by a female anopheles mosquito's infective bite in searching for a blood meal to nurture its eggs. Of the five parasite species that cause malaria in humans, two (*Plasmodium falciparum* and *Plasmodium vivax*) are most dangerous – as in 2018, *P. falciparum* accounted for 99.7% of estimated malaria cases in the WHO African Region while *P. vivax* was responsible for 75% of malaria cases in the WHO Region of the Americas [3]. The interplay between vector, parasite, human host and environmental factors are key in determining the intensity of malaria transmission. Incidentally, Nigeria possess the blend of all requisite factors (rainfall, temperature, and humidity) for the breeding and survival of female anopheles mosquitoes [4].

Incidentally, in most surveys and intervention programmes on malaria, very minimal attention has been given to school age children [5]. Whereas it is true that children in the lower age bracket have been shown to suffer more from malaria [2], reports have also shown that there are more than 500 million school-age children worldwide who are at risk of malaria infection, 200 million of whom reside in SSA [6]. Some studies have demonstrated higher prevalence of *Plasmodium* infection among primary school age children than among younger children and thereby affecting the former's academic performance [7]. During high transmission seasons and settings it is believed that older children tend to acquire partial immunity against malaria parasite, thereby making them a potential reservoir for continued malaria transmission in the community [8]. It is in the light of this that trials on mass treatment to clear residual parasitaemia otherwise known as intermittent parasite clearance in schools

(IPCs), have been piloted with the aim of reducing malaria infections among school children and thereby improving their capacity to pay attention in class [7].

According to the 2016 Malaria Indicator Survey (MIS), in Nigeria, children in rural areas are three times more likely to test positive for malaria than their urban counterparts - 36% compared with 12 %, respectively [9]. According to the survey malaria prevalence was highest (37%) in North West Nigeria, and lowest (14%) in the South. The survey also indicated that in GombeState RDT test revealed a much higher (46.5%) Malaria prevalence than what was recorded by microscopy. These differentials in malaria burden reflects in most socio-demographic background of children. In a study in Anambra state South Eastern Nigeria pupils of parents with no formal education were found to have the highest malaria prevalence compared to children of parents with tertiary education had the least (49.0% vs. 11.0%) [2]. Hence, this study was designed to assess the burden of malaria and related differentials in pattern of distribution among asymptomatic primary school children in Gombe state, Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Gombe State is located in the North-East sub region of Nigeria between Latitude 9°30' and 12° N and Longitude.8°45' and 11°45'E. It shares boundaries with Yobe state to the north, Borno and Adamawa states to the east, Bauchi state to the west and Taraba State to the south [10]. Gombe state has a land mass area of 20, 265 square kilometers with a population of 3,545,032 projected from the 2006 national census. The state consists of 11 Local Government Areas (LGAs) (see Fig. 1). Based on climatic differences Gombe state can be divided into three zones that approximately squares with the three senatorial districts, namely; Southern Guinea Savanna (SGS) in Gombe south, Northern Guinea Savanna (NGS) in Gombe central and Sudan Savanna (SS) in Gombe north [10]. About 85% of the rainfall pattern observed in Gombe state approximately spans through April to October, but are heaviest in July, August and September [11]. These geographic variables that characterize different parts of Gombe are also known to affect the pattern of distribution of malaria infection in such settings [2,4,5,6].

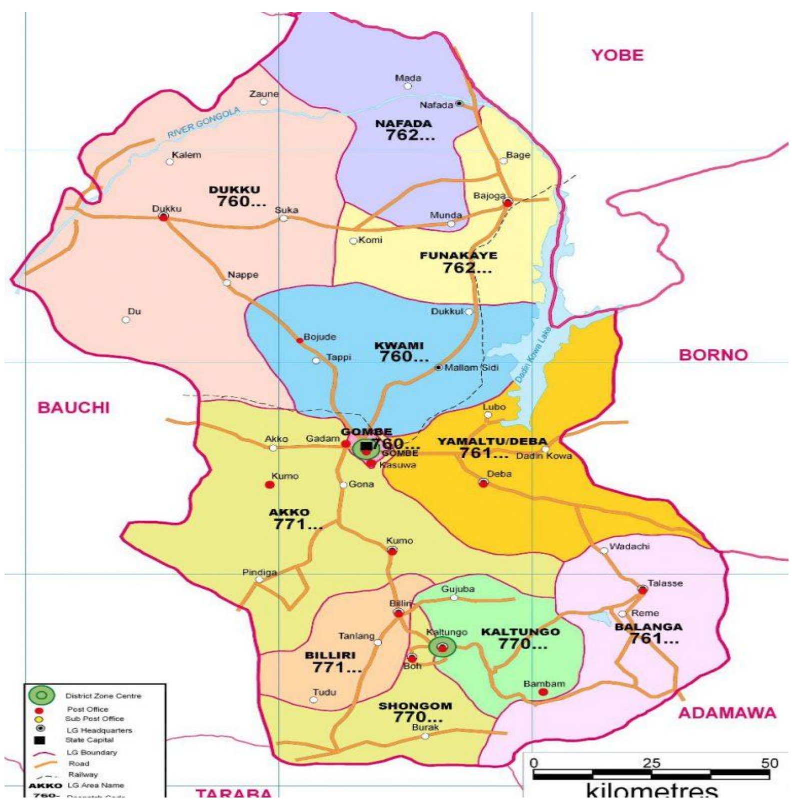


**Fig. 1. Map of Gombe state showing the 11 LGAs**

## 2.2 Study Design and Setting

This study adopted a cross sectional study design, to determine the prevalence of malaria among school children selected from 12 public and 6 private primary schools in six (6) Local Government Areas (LGAs) of Gombe State, Nigeria.

## 2.3 Study Participants

The study participants were primary school pupils aged 6-15 in Gombe state.

## 2.4 Eligibility Criteria

### 2.4.1 Inclusion criteria

All male or female school children aged 6 - 15 who were registered in selected primary schools in Gombe state who were willing to participate in the study during data collection. They must also have resided in the state for not less than one year. Verbal consent for participation of subjects was secured from the Parents Teachers Association (PTA) through the management of selected schools. This was in addition to the ethical clearance obtained from the state ministry of health and approval letters obtained from the various local government education authorities (LEAs).

### 2.4.2 Exclusion criteria

All pupils outside the age group of 6 - 15 years who were not registered in selected primary schools in Gombe state or who were unwilling to participate in the study during data collection; and who may not have resided in the state for at least one year.

## 2.5 Sample Size Determination

Sample Size determination was done using Pocock's sample size formula for comparing two proportions [12,13].

n = $[P1\ (1 - P1)\ +\ P2\ (1 - P2)]\ (Z\alpha/2\ +\ Z\beta)2\ /(P1 - P2)2$

Where:

n: required sample size

*P*1: estimated proportion of malaria in urban areas (about 12%)

*P*2: estimated proportion of malaria in rural areas (comparison group) in the North East (about 36%) [12,13]

α: level of statistical significance

Zα/2: Represents the desired level of statistical significance (typically 1.96 for α = 0.05)

Z β: Represents the desired power (typically 0.84 for 80% power)

n for each group *2= total sample (i.e. for the 2 groups)

The calculations ensured that the minimum detectable difference in malaria infection among the school children in rural and urban areas, or in public and private schools; was 10%.

The calculated minimum sample size for the study was 295 children from urban schools and 295 from rural schools. Put together a minimum sample size of 590 was obtained. However, the final sample size used was 745.

## 2.6 Sampling Technique

As at 2018 there were 573 private and 1, 341 public primary schools constituting a total of1, 914 Primary Schools in Gombe state [14]. This implies a private-public schools ratio of 1:2.3. Therefore, 6 private and 12 public primary schools were selected from both urban and rural areas of the state. A sample of 745 children were selected using multistage sampling technique. Using simple random sampling two LGAs were selected from each senatorial district. In stage two three primary schools comprising a public primary school from a rural area, and one public and one private school from an urban or suburban area, were selected per LGA. In all 18 schools were selected. Thereafter (stage three) 4 classes were selected randomly from primary one to primary six. Finally (stage four) a minimum of 40 pupils per school were selected from primary 1-6. Participation of subjects was entirely on voluntary basis.

## 2.7 Data Collection Methods

### 2.7.1 Face to face interview of subjects

Subjects were first taken through an oral interview in which socio-demographic and other relevant information about them and their parents or guardians were collected on a data collection template/questionnaire. Thereafter, a malaria screening test was conducted on each of them and the results documented on the template. Data collection took place between March and June, 2019.

#### 2.7.2 Malaria rapid diagnostic test (mRDT) kits screening of pupils

Malaria Rapid Diagnostic Test (mRDT) kits were used to screen and categorize subjects as positive or negative for malaria parasites based on the presence or absence of malaria parasite in the blood. The SD BIOLINE Malaria Ag P.f (HRP-II)™ rapid diagnostic test (RDT), which is a qualitative test to detect histidine-rich protein II antigen of malaria *Plasmodium falciparum* in human whole blood, was used [9]. Available evidence show that RDT could have a sensitivity of 99% and a specificity of 85% compared to light microscopic examination of Giemsa-stained peripheral blood films [15]. A micropipette was used to obtain 5 µL of peripheral blood sample from finger prick of the school children and dispensed into the small well of the testing kit with 2 drops of assay buffer subsequently added, and the result was read in 10-15 minutes. The presence of 2 color bands within the result window indicated a positive result while only 1 band indicates a negative. Children found to be RDT-positive were treated with a six dose regimen of artemisinin-based combination therapy (ACT) according to WHO guidelines irrespective of symptoms [16].

### 2.8 Data Management and Analysis

The data collected were analyzed using IBM Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc. Chicago, IL, USA). Descriptive and inferential statistics were used to summarize and draw conclusions on the data. Chi square ($\chi^2$) and odd ratio (OR) were computed and used to compare proportions and estimate risks of malaria infection among the subjects. Findings were considered significant at P-values less than 0.05. Data were presented in tables and charts.

## 3. RESULTS

Out of the 745 pupils studied, 131 representing 17.6% of the pupils were from Akko LGA which had the highest proportion of participants, while Billiri and Gombe LGAs had the lowest (121, 16.2%). Based senatorial district, Gombe central had the highest number of pupils selected (253, 34.0%). Pupils from primary 3, from public and from urban schools (164/22.0%, 499/67%, 455/61.1% respectively) were in majority (Table 1).

According the socio-demographic factors (Table 2), majority (325/43.6%) of the children were Hausa/Fulani by tribe. Majority of them (730/98.1%) were singleton by birth, and a great proportion of them (80.3%) received parental care from paternal and maternal background. An overwhelming majority (83.7%) of the pupils were within at least the 5$^{th}$ birth order. Furthermore, a large proportion (85.9%) of the children were at least 12 years of age. Though there was a slight male to female (50.9% vs. 49.1%) preponderance, male-female sex ratio was about 1:1. Children of Islamic faith leaning (55.0%) were slightly more in number. Again, little more than half (54.0%) of the pupils' family size were at least seven.

By occupational and educational background (Table 3) greater majority (83.8%) of the pupil's fathers were either farmers or civil servants, whereas their mothers were mostly (65.0%) housewives. Slightly more than half (54.0%) of the subjects' families were within low socio-economic status (SES). An appreciable proportion of the children's fathers have had secondary (39.3%) and tertiary education (37.6%), while slightly less percentage of their mothers (36.8%) had secondary school education and a comparatively lower proportion of them (21.7%) had tertiary education.

Out of the 745 subjects sampled and screened, 101 of them representing 13.6% tested positive for malaria parasites using mRDT (Fig. 2). And all of them (positive cases), though asymptomatic, were treated with full regimen of artemisinin-based combination therapy (ACT) based on their age and in accordance with the WHO recommended guideline.

Differences in the prevalence of malaria infection among the pupils reflects the different study area variables (Table 4). Higher prevalence of the disease were noted among pupils from Billiri (21.5%) and Shongom (28.7%) LGAs (*p*=0.000). Again, children from southern senatorial district bore the highest burden (25.1%) of malaria (*p*=0.000). Furthermore, pupils from publicly owned schools were mostly (18.2%) affected by and had were 5 times (OR=5.264, CI=2.687-10.311) more at risk of malaria than their counterparts in the private schools (*p*=0.000). In the same vein, children from schools in rural areas were significantly (*p*=0.000) most affected (22.4%) and were about 3 times more at risk of malaria that their counterparts in urban schools (OR=3.362, CI=2.169-5.212).

**Table 1. Background information about the study area and sample size (n=745)**

| Variable/Category | Frequency (n) | Percentage |
|---|---|---|
| **Number of Children Sampled per LGA in 3 schools each** | | |
| Billiri | 121 | 16.2 |
| Shongom | 122 | 16.4 |
| Akko | 131 | 17.6 |
| YamaltuDeba | 122 | 16.4 |
| Gombe | 121 | 16.2 |
| Funakaye | 128 | 17.2 |
| Total | 745 | 100.0 |
| **Senatorial Districts** | | |
| Gombe South | 243 | 32.6 |
| Gombe Central | 253 | 34.0 |
| Gombe North | 249 | 33.4 |
| Total | 745 | 100.0 |
| **Ownership Status** | | |
| Public | 499 | 67.0 |
| Private | 246 | 33.0 |
| Total | 745 | 100.0 |
| **Place of residence** | | |
| Rural | 290 | 38.9 |
| Urban | 455 | 61.1 |
| Total | 745 | 100.0 |
| **Class of pupils** | | |
| primary 1 | 133 | 17.9 |
| primary2 | 134 | 18.0 |
| primary3 | 164 | 22.0 |
| primary4 | 140 | 18.8 |
| primary5 | 94 | 12.6 |
| primary6 | 80 | 10.7 |
| Total | 745 | 100.0 |

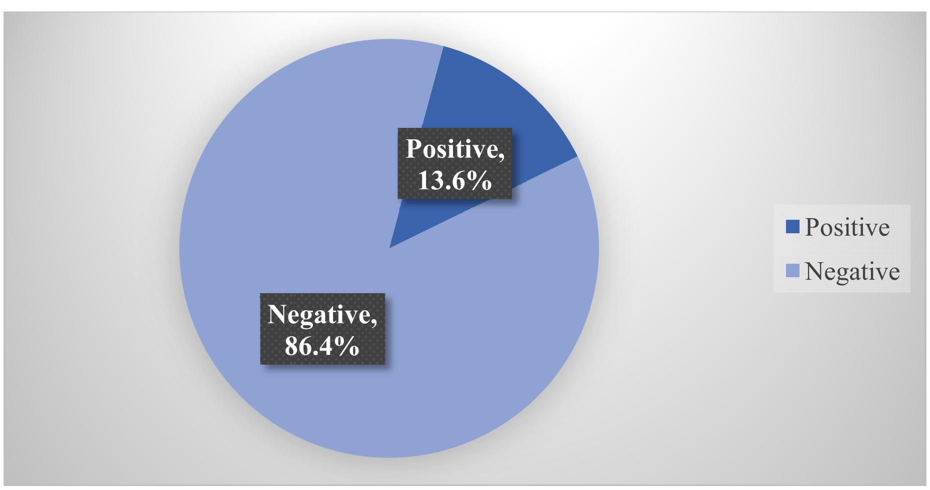


**Fig. 2. Proportion of Subjects/pupils that tested positive for Malaria using mRDT**

**Table 2. Socio-demographic background of school children**

| Variable/Category | Frequency (n) | Percentage |
|---|---|---|
| **Tribe (n=745)** | | |
| Hausa/Fulani | 325 | 43.6 |
| Tangale/Waja/ etc | 173 | 23.2 |
| Tera/Kanuri/Bolewa | 102 | 13.7 |
| Others-Yoruba/Igbo etc | 145 | 19.5 |
| Total | 745 | 100.0 |
| **Birth Description (n=744)** | | |
| Singleton | 730 | 98.1 |
| Twin | 14 | 1.9 |
| Total | 744 | 100.0 |
| **Source of parental care (n=745)** | | |
| Father and mother | 598 | 80.3 |
| Father/mother/Guardians | 147 | 19.7 |
| Total | 745 | 100.0 |
| **Birth Order (n=745)** | | |
| < $3^{rd}$ | 314 | 42.1 |
| $3^{rd}$-$5^{th}$ | 310 | 41.6 |
| $6^{th}$+ | 121 | 16.2 |
| Total | 745 | 100.0 |
| **Age group (n=745)** | | |
| <= 9 | 307 | 41.2 |
| 10-12 | 333 | 44.7 |
| 13+ | 105 | 14.1 |
| Total | 745 | 100 |
| **Gender (n=745)** | | |
| Male | 379 | 50.9 |
| Female | 366 | 49.1 |
| Total | 745 | 100.0 |
| **Religion (n=745)** | | |
| Christianity | 335 | 45.0 |
| Islam | 410 | 55.0 |
| Total | 745 | 100.0 |
| **Family size** | | |
| <= 7 | 399 | 54.0 |
| 8+ | 340 | 46.0 |
| Total | 739 | 100.0 |

Table 5 shows the association between malaria and the school children's socio-demographic characteristics. Children from the Hausa/Fulani tribal background recorded the lowest prevalence of Malaria (10.5%) and the observation was significant at $p$=0.000. Children in care of single parents had more malaria cases (19.7% vs. 12.0%) than those in care of both parents ($p$=0.015). School children of Christian religious leaning (17.0%) suffered more and were about twice at risk of malaria than their counterparts of the Islamic (10.7%) faith (OR=1.706, CI = 1.117-2.604). Children from bigger family size (8+) suffered more (16.8% vs. 10.8%) from malaria than those from smaller size (<= 7) families ($p$=0.018).

The associations between malaria infection and the subjects' parental socio-economic background variables were analyzed (Table 6).

Children of Farmers/artisans/Traders paternal background suffered more from malaria (19.2%) than those from other occupational groups (*p*=0.000). Likewise, children of house wives (15.8%) and artisan/farmer (16.4%) maternal background suffered more from malaria than those of mothers from other occupations (*p*=0.001). Children from the lower SES suffered more (21.1%) from malaria than those from higher SES (*p*=0.000). Again, children of fathers with only primary school or no education suffered more from malaria (22.9%) than those of fathers with higher educational level (*p*=0.000). Furthermore, children of mothers with only primary school or no education suffered more from malaria (20.2%) than those of mothers with higher education (*p*=0.000).

A good proportion (41.8%) of the subjects slept inside treated mosquito nets the night before the survey. From Table 7, it is clear that sleeping inside the mosquito net was significantly (p=0.000) associated with low prevalence of malaria infection (8.1% vs. 17.6%). The odds of having malaria infection was more than twice (OR=2.432, CI=1.508-3.923) among children who didn't sleep inside mosquito net, the night before the survey. The level of academic performance was also found to be associated with malaria infection as children within the lower performance category were found to have suffered most from malaria infection (18.1% vs. 12.0% & 8.8%) than children with medium and high academic performance (p=0.012).

**Table 3. Occupational and educational background of the parents/care giver**

| Variable/Category | Frequency | Percentage |
|---|---|---|
| **Occupation of father (n=737)** | | |
| Farmer/artisan/Trader/etc | 334 | 45.3 |
| Civil Servant/Banker/etc | 284 | 38.5 |
| Top Business man/etc | 119 | 16.1 |
| Total | 737 | 100.0 |
| **Occupation of mother (n=742)** | | |
| Farmer/Artisan/Trader/ etc | 116 | 15.6 |
| Civil servant/Banker/etc | 127 | 17.1 |
| Top Business woman/erc | 17 | 2.3 |
| House wife | 482 | 65.0 |
| Total | 742 | 100.0 |
| **Socioeconomic status (SES) (n=745)** | | |
| Low | 402 | 54.0 |
| Middle | 252 | 33.8 |
| High | 91 | 12.2 |
| Total | 745 | 100.0 |
| **Educational level of father (n=737)** | | |
| Primary School | 170 | 23.1 |
| Secondary School | 290 | 39.3 |
| Tertiary Institution | 277 | 37.6 |
| Total | 737 | 100.0 |
| **Educational level of mother (n=741)** | | |
| Primary School | 307 | 41.4 |
| Secondary School | 273 | 36.8 |
| Tertiary Institution | 161 | 21.7 |
| Total | 741 | 100.0 |

**Table 4. Association between malaria (mRDT) and Study area**

| Variable/ Category | Malaria (mRDT) | | OR | CI | Chi Sq | df | *p*-value |
|---|---|---|---|---|---|---|---|
| | Positive, n (%) | Negative | | | | | |
| **Pupil's LGA** | | | | | | | |
| Billiri | 26 (21.5%) | 95 (78.5%) | | | | | |
| Shongom | 35 (28.7%) | 87 (71.3%) | | | | | |
| Akko | 11 (8.4%) | 120 (91.6%) | | | | | |
| YamaltuDeba | 11 (9.0%) | 111 (91.0%) | | | | | |
| Gombe | 4 (3.3%) | 117 (96.7%) | | | | | |
| Funakaye | 14 (10.9%) | 114 (89.1%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | **47.052** | **5** | **0.000*** |
| **Sentorial District** | | | | | | | |
| South | 61 (25.1%) | 182 (74.9%) | | | | | |
| Central | 22 (8.7%) | 231 (91.3%) | | | | | |
| North | 18 (7.2%) | 231 (92.8%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | 41.252 | 2 | 0.000* |
| **School Ownership Status** | | | | | | | |
| Public | 91 (18.2%) | 408 (81.8%) | | | | | |
| Private | 10 (4.1%) | 236 (95.9%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | 5.264 | (2.687-10.311) | 28.237 | 1 | 0.000* |
| **Location/ Place of residence** | | | | | | | |
| Rural | 65 (22.4%) | 225 (77.6%) | | | | | |
| Urban | 36 (7.9%) | 419 (92.1%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | 3.362 | (2.169-5.212) | 31.783 | 1 | 0.000* |
| **Class of pupils** | | | | | | | |
| primary 1 | 13 (9.8%) | 120 (90.2%) | | | | | |
| primary2 | 17 (12.7%) | 117 (87.3%) | | | | | |
| primary3 | 23 (14.0%) | 141 (86.0%) | | | | | |
| primary4 | 23 (16.4%) | 117 (83.6%) | | | | | |
| primary5 | 14 (14.9%) | 80 (85.1%) | | | | | |
| primary6 | 11 (13.8%) | 69 (86.3%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | 2.872 | 5 | 0.720 |

** p<0.05*

**Table 5. Association between malaria (mRDT) and child's socio-demographic characteristics**

| Variable/ category | Malaria (mRDT) | | OR | CI | Chi Sq | df | *p*-value |
|---|---|---|---|---|---|---|---|
| | Positive n (%) | Negative n (%) | | | | | |
| **Tribe** | | | | | | | |
| Hausa/Fulani | 34 (10.5%) | 291 (89.5%) | | | | | |
| Tangale/Waja/ etc | 28 (16.2%) | 145 (83.8%) | | | | | |
| Tera/Kanuri/Bolewa | 5 (4.9%) | 97 (95.1%) | | | | | |
| Others-Yoruba/Igbo etc | 34 (23.4%) | 111 (76.6%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | **22.302** | **3** | **0.000*** |
| **Source of parental care** | | | | | | | |
| Father and mother | 72 (12.0%) | 526 (88.0%) | | | | | |
| Father or mother only or Guardians | 29 (19.7%) | 118 (80.3%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | 0.557 | (0.346-0.896) | 5.951 | 1 | 0.015* |
| **Birth Order** | | | | | | | |
| < 3 | 45 (14.3%) | 269 (85.7%) | | | | | |
| 3-5 | 34 (11.0%) | 276 (89.0%) | | | | | |
| 6+ | 22 (18.2%) | 99 (81.8%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | 4.142 | 2 | 0.126 |
| **Age group** | | | | | | | |
| < 10 | 34 (11.1%) | 273 (88.9%) | | | | | |
| 10-12 | 54 (16.2%) | 279 (83.8%) | | | | | |
| 13+ | 13 (12.4%) | 92 (87.6%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | | | 3.747 | 2 | 0.154 |
| **Gender** | | | | | | | |
| Male | 57 (15.0%) | 322 (85.0%) | | | | | |
| Female | 44 (12.0%) | 322 (88.0%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | 1.295 | (0.849-1.977) | 1.447 | 1 | 0.229 |
| **Religion of Pupil** | | | | | | | |
| Christianity | 57 (17.0%) | 278 (83.0%) | | | | | |
| Islam | 44 (10.7%) | 366 (89.3%) | | | | | |
| Total | 101 (13.6%) | 644 (86.4%) | 1.706 | (1.117-2.604) | 6.211 | 1 | 0.013* |
| **Family Size** | | | | | | | |
| <= 7 | 43 (10.8%) | 356 (89.2%) | | | | | |
| 8+ | 57 (16.8%) | 283 (83.2%) | | | | | |
| Total | 100 (13.5%) | 639 (86.5%) | 0.6 | (0.392-0.918) | 5.625 | 1 | 0.018* |

** p<0.05*

**Table 6. Association between malaria (mRDT) and Parent's Socio-economic background**

| Variable/Category | Malaria (mRDT) | | Chi Sq | df | *p*-Value |
|---|---|---|---|---|---|
| | Positive n(%) | Negative n(%) | | | |
| **Occupation of father** | | | | | |
| Farmer/artisan/Trader | 64 (19.2%) | 270 (80.8%) | | | |
| Civil Servant /Banker/ Military etc | 23 (8.1%) | 261 (91.9%) | | | |
| Top Business man/Politician etc | 12 (10.1%) | 107 (89.9%) | | | |
| Total | 99 (13.4%) | 638 (86.6%) | 17.524 | 2 | 0.000* |
| **Occupation of mother** | | | | | |
| Farmer/Artisan | 19 (16.4%) | 97 (83.6%) | | | |
| Civil servant/Banker/Military etc | 6 (4.2%) | 138 (95.8%) | | | |
| House wife | 76 (15.8%) | 406 (84.2%) | | | |
| Total | 101 (13.6%) | 641 (86.4%) | 13.585 | 2 | 0.001* |
| **Socioeconomic Status (SES)** | | | | | |
| Low | 85 (21.1%) | 317 (78.9%) | | | |
| Middle | 14 (5.6%) | 238 (94.4%) | | | |
| High | 2 (2.2%) | 89 (97.8%) | | | |
| Total | 101 (13.6%) | 641 (86.4%) | 43.534 | 2 | 0.000* |
| **Level of education of father** | | | | | |
| Primary School or none | 39 (22.9%) | 131 (77.1%) | | | |
| Secondary School | 46 (15.9%) | 244 (84.1%) | | | |
| Tertiary Institution | 15 (5.4%) | 262 (94.6%) | | | |
| Total | 100 (13.6%) | 637 (86.4%) | 29.737 | 2 | 0.000* |
| **Level of education of mother** | | | | | |
| Primary School or none | 62 (20.2%) | 245 (79.8%) | | | |
| Secondary School | 29 (10.6%) | 244 (89.4%) | | | |
| Tertiary Institution | 10 (6.2%) | 151 (93.8%) | | | |
| Total | 101 (13.6%) | 640 (86.4%) | 20.865 | 2 | 0.000* |

** p<0.05*

**Table 7. Association between malaria (mRDT) and Childs academic performance & Mosquito Net Use**

| Variable/Category | Malaria (mRDT) | | OR (95% Conf Interval) | $\chi^2$/df/*p*-Value |
|---|---|---|---|---|
| **Childs level of academic performance (n=738)** | | | | |
| | Positive, n (%) | Negative, n (%) | | |
| Low/poor (<50) | 44 (18.1%) | 199 (81.9%) | | |
| Medium/Good (50-69) | 36 (12.0%) | 265 (88.0%) | | |
| High/Very good (=>70) | 17 (8.8%) | 177 (91.2%) | | |
| Total | 97 (13.1%) | 641 (86.9%) | | 8.874/2/0.012* |
| **Slept inside mosquito net the night before the survey (n=740)** | | | | |
| No | 76 (17.6%) | 355 (82.4%) | | |
| Yes | 25 (8.1%) | 284 (91.9%) | | |
| Total | 101 (13.6%) | 639 (86.4%) | 2.432 (1.508-3.923) | 13.906/1/0.000* |

** p<0.05*

## 4. DISCUSSION

The 745 school children studied ranged from 6 to 15 years old with a mean of 9.96±2.26 years. All were screened for malaria parasitamia using mRDT and a total of 101 of them representing 13.6% tested positive. This finding falls within the range of malaria infection among school age children in the African region - from 4% overall prevalence and a range of 0-71% in Kenya; 5-

50% in Senegal, The Gambia, and Mauritania; 50% in Cameroon, 14-64% in Uganda to 79.8% in Mali [5,7]. However, it is quite lower than other findings in some southern parts of Nigeria. In Anambra state overall prevalence of malaria parasites infection among school children ranged from 25% to 86.46% [2,17]. In Ebonyi state Ani reported an overall malaria prevalence of 40.08% within a range of 22-52% [18]. From another Nigerian southern state (Bayelsa) Abah and Temple reported another higher prevalence (63.3%) of malaria infection among asymptomatic primary school pupils [19]. However, Ekpenyong and Eyo reported a relatively lower rate (20.8%) from another southern state (Enugu) with one of the primary Schools (Itchi community primary school) having about a similar finding (13.9%) to that of this study (13.6%) [20]. This notable and significant difference in malaria infection prevalence in this (Nigerian northern state) study compared to those from the south is most likely due to factors such as rainfall patterns and proximity of human dwelling places to vector breeding sites among others [3,21]. And all positive cases, though asymptomatic, were treated with full regimen of artemisinin-based combination therapy (ACT) based on their age and in accordance with the WHO recommended guideline [3,22].

Furthermore, differences in the prevalence of malaria infection among the pupils also reflected the different study area variables (Table 4). The significantly (*p*=0.000) higher prevalence of the disease noted among pupils from Billiri (21.5%) and Shongom (28.7%) LGAs and generally among children in the southern senatorial district (25.1%) may not be unconnected with the fact that these areas lie within the more humid and vegetative southern Guinea savannah where favourable environmental factors for the breeding of vectors (female anopheles mosquitos) abound and hence the likelihood for higher transmission of the parasites (*p. falcifarum*) [10,11]. Additionally, pupils from publicly owned schools had significantly (*p*=0.000) higher prevalence and were about 5 times more at risk of malaria infection than their counterparts in the private schools (18.2% vs. 4.1%). This is consistent with findings of other studies in Nigeria [2,23]. This observation is perhaps due to the fact that patronage of private schools is mostly by children of the well-to-do or the high and middle class workers who are able to afford the prohibitively high school fees usually charged by private school proprietors [24]. This creates a scenario whereby the usually ill-equipped public schools are left to be patronized by children of the common man. And available evidence has shown a strong correlation between malaria and poverty (and hence public school attendance) owing to lack of affordability of preventive measures and treatment [25]. On the contrary Ogolo et al, working among Secondary School Students in Oba Idemili South Local Government Area, Anambra State Nigeria reported that private school students recorded a higher prevalence of malaria infection (13.5%) than their counterparts in public schools (6.2%) [26]. This might have been due to other overriding environmental factors that may not have been considered in the selection of study settings in this particular study area [21,27].

This study also demonstrated that children from schools in rural areas were significantly (*p*=0.000) most affected (22.4%) with more than 3 times risk of malaria infection than their counterparts in urban schools. This is in tandem with the findings from other African countries and Nigeria. In Gabon Maghendji-Nzondo et al reported that overall prevalence of malaria infection was higher in rural areas than in semi-urban and urban areas [28], and from Ghana Kweku et al reported that malaria prevalence was significantly higher in rural than urban (42.5% vs. 25.2%; $p<0.001$) as indicated by the RDT [29]. Similar observation was reported by Olusegun-Joseph et al from Lagos, Nigeria [30]. Overall, a good number of African countries depicts a rising trend of malaria transmission from urban to peri-urban to rural settings [31]. Differences in lifestyle has been implicated as the main reason for urban-rural differentials in the prevalence of malaria infection in most Nigerian settings [27]. Additionally, in urban settings malaria transmission could be low due to the urbanization/ environmental changes itself, and other factors like pollution could adversely affect the suitability of larval habitats, mosquito survival and ability or likelihood to transmit malaria (i.e., vectorial capacity) [32]. Other differences might include better housing with physical barriers such as screens, doors, use of insecticides and bed nets. Higher human population densities may also reduce individual biting rates [33,34].

This study also shows that there was a clear association between malaria and the school children's socio-demographic characteristics (Table 5). Children of the Hausa/Fulani extraction recorded a significantly (*p*=0.000) lower prevalence of Malaria infection (10.5%). The possible reason for this could be geographic location whereby the Hausa/Fulani children are mostly in the northern (Sudan Savanna) and central (Northern Guinea Savanna) districts with less vegetation, less humidity and less rainfall which could be discouraging factors for breeding sites of mosquitoes and hence low malaria transmission [27,32]. Children in care of single parents had more malaria cases (19.7% vs. 12.0%) than those in care of both parents (*p*=0.015). It goes without saying that children that enjoyed the joint care of either parents or guardians would be afforded more preventive facilities and treatment for malaria [35]. Again, school children of Christian religious leaning (17.0%) suffered more and were about twice at risk of malaria infection than their counterparts of the Islamic faith (10.7%) faith. The rationale for tribe and geographical location also applies here inasmuch as almost all children that were Hausa/Fulani by tribe were also of the Islamic faith and also domicile in the north and central senatorial districts, thereby subjecting them to the same ecological, environmental and sociocultural dynamics that discourages the breeding of vectors and therefore low malaria transmission and prevalence [27]. Children from bigger family size (8+) suffered more (16.8% vs. 10.8%) from malaria than those from smaller size (<= 7) families (*p*=0.018). Large family size is often associated with poor socioeconomic status and environmental state of families which in turn when compromised exposes the family members to many diseases including malaria [36,37,38]. As also noted in the work of Ani in Ebonyi state, Nigeria [18], though this study indicated higher prevalence of malaria infection among male school children (15.0% vs. 12.0%), the difference was not statistically significant (*p*=0.229), but in the work of Ekpenyong and Eyo in Enugu state, south eastern Nigeria the difference was quite significant [20]. However, from the evidence of this study there was no significant association between the prevalence of malaria infection and birth order, age group and gender of the school children. Some extant literature suggest that there is significant association between age and malaria prevalence in which children in lower age groups are worst hit [2,18,19,20]. The argument for this trend has mainly been predicated on the acquisition of partial immunity by the older school age children following repeated exposure to infective mosquito bites that tend to provoke some immune reaction by the body, in addition to having higher tendency for imbibing self-protective measures [2,5,8]. The possible reason for the seeming contradiction in this study might border on lifestyle issues, genetics and environmental factors.

The analysis of associations between malaria infection and the subjects' parental socio-economic background variables (Table 6) showed that children of Farmers/artisans/Traders paternal background suffered more from malaria (19.2%) than those from other occupational groups (*p*=0.000). Likewise, children of house wives (15.8%) and artisan/farmer (16.4%) maternal background suffered more from malaria than those of mothers from other occupations (*p*=0.001). Furthermore, children from the lower SES suffered more (21.1%) from malaria than those from higher SES (*p*=0.000). Again, children of fathers with only primary school or no education suffered more from malaria (22.9%) than those of fathers with higher educational level (*p*=0.000). Children of mothers with only primary school or no education suffered more from malaria (20.2%) than those of mothers with higher education (*p*=0.000). This observed trend of associations between socioeconomic status variables and malaria prevalence aligns with several other findings showing higher prevalence among subjects within the lower SES [36,37,38, 39,40]. The inverse association between paternal and maternal level of education with the prevalence rate of malaria infection is corroborated by several other findings [2,27,39]. This is because it stands to reason that persons with higher education are more likely to be enlightened on taking preventive and curative measures against most diseases including malaria.

It is obvious that an appreciable (41.8%) of the subjects slept inside treated mosquito net the night before the survey. From Table 7, it is clear that sleeping inside the mosquito net was significantly (*p*=0.000) associated with low prevalence of malaria infection (8.1% vs. 17.6%). The odds of having malaria infection was more than twice among children who didn't sleep inside mosquito net, the night before the survey. This agrees with other findings from south eastern Nigeria in which the prevalence of malaria was significantly lower among pupils using preventive measures; 5.9% among pupils using mosquito bed net as against 21.2% among those not using bed nets [20]. The level of academic performance was also found to be associated with malaria infection as children within the lower performance category were found to have suffered most from malaria infection (18.1% vs. 12.0% & 8.8%) than children with medium and high academic performance ($p$=0.012). This finding is also in agreement with other findings in Nigeria, Africa and other developing countries [5,7,8,27]. Though there are a few conflicting reports, abundant evidence suggest that there is a strong association between malaria prevalence and school absenteeism, lack of attention, cognition and academic performance [5,7,40, 41,42].

## 5. CONCLUSION

The findings of this work reinforces existing evidence that there is an existential threat of malaria infection with disproportionate spread of the burden among school children in different parts of Gombe state and along their socio-demographics. The overall burden of 13.6% malaria infection prevalence is unacceptable. And the findings of this study has further elucidated the fact that malaria infection is associated with place of residence, Ownership or type of school, Senatorial district, Family size, LGA, source of parental care, Tribe, Religion, Occupation of father, Occupation of mother, SES, Level of Education of father and Level of Education of mother. However, from the evidence of the study there was no significant association between the prevalence of malaria infection and birth order, age group and gender of the school children. The apparent advantage and the impact of treated bed nets was highlighted by the fact that minimal prevalence of malaria infection (8.1% vs. 17.6%) was recorded among subjects who slept inside the net a night before the survey. And the significant association between the prevalence of malaria infection and poor academic performance underscores the urgent need for instituting school-based distribution of long lasting insecticidal nets (LLINs) and deployment of mRDT kit screening of asymptomatic school children as well as treatment of detected cases with the WHO recommended Artemisinin-based Combination Therapy (ACTs) using trained teachers. Finally, school children should be mainstreamed into malaria control and elimination programmes of government.

## CONSENT AND ETHICAL APPROVAL

Permission and approval of the overseeing government parastatals such as the Gombe State Universal Basic Education Board (SUBEB) and the Local Education Authority (LEA) of the six Local Government Areas (LGAs) were obtained. Ethical clearance was also secured from the Gombe State Ministry of Health Research and Ethics Committee (GSMoHREC) – Ref: MoH/ADM/S/658. Consent of the heads of the 18 schools visited, the parents and the participating pupils were all obtained before embarking on the data collection. Pupils were assured that at any point they so wished they could opt out of the study.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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