



## **Prevalence of Malaria Parasitaemia and Its Association with ABO Blood Grouping among Students of Igbinedion University Okada, Nigeria**

**F. D. Otajevwo<sup>1\*</sup>**

<sup>1</sup>*Department of Microbiology and Biotechnology, Western Delta University, Oghara, Nigeria.*

### **Author's contribution**

*This work was carried out by author FDO of the Western Delta University, Oghara, Nigeria.*

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### **ABSTRACT**

This study was carried out to investigate ABO blood groups association with malaria parasitaemia among students of Igbinedion University, Okada located in Mid-Western Nigeria. Two milliliters (2ml) of venous blood was collected by venipuncture using 5ml hypodermic needles and syringes from 104 asymptomatic malaria students between March and June 2012. Blood samples were immediately dispensed into Ethylene Diamine Tetra-Acetic acid (EDTA) anticoagulated containers and mixed appropriately. ABO blood typing using monoclonal Antisera A, B and D was carried out on samples. The malaria *Plasmodium falciparum* rapid Test Device (whole blood) package insert kit (BDH, England) was used to test for the presence of malaria parasites in the specimens. The 104 samples analyzed were made up of 24(23.1%) rhesus positive males, 76(73.0%) rhesus positive females and 4(3.9%) rhesus negative females. In increasing order, 4(3.9%), 16(15.4%), 32(30.8%) and 52(50.0%) students occurred in blood groups AB, A, B and O respectively. Forty (38.4%) of total group O subjects were infected with various densities of malaria trophozoites. Out of 32 blood group B individuals representing 30.8% of the total sampled students, 24(23.1%) were infected. All sampled 4(3.9%) AB students were infected. On the whole, 80(76.8%) of total samples processed, were positive for malaria parasitaemia. Twelve (11.5%) and 68(65.4%) of total male and female subjects were infected. Malaria parasitaemia seemed to be relatively high across all blood groups with groups O and AB subjects apparently recording the highest and least infection rates

\*Corresponding author: Email: [dafinotaj@yahoo.com](mailto:dafinotaj@yahoo.com);

respectively. There was statistical significant association between malaria parasitaemia and ABO blood groups of both male and female students ( $P < 0.05$ ) and between malaria parasitaemia and ABO blood groups of female students only ( $P < 0.05$ ). The association of malaria parasitaemia and ABO blood groups of male students was not significant ( $P > 0.05$ ). There was a statistical significant association of malaria parasitaemia and ABO blood groups among all students sampled and this association may be due to the significant association that occurred among the female students as shown by statistics.

**Keywords:** Malaria; parasitaemia; association; ABO; blood; groups; students; university.

## 1. INTRODUCTION

In spite of concerted efforts being made by several countries and agencies to eradicate malaria parasite, malaria remains enigmatic and continues to rank among the foremost killer diseases of our time [1]. The disease affects about 500 million people and kills about 2 million, mostly children each year [2].

Despite the high morbidity and mortality, certain individuals living in malaria endemic regions appear relatively protected compared to those who suffer frequent severe malaria attacks. Resistance to malaria infection is dependent on the development of an immune response by the host and to a varying extent, on certain innate characteristic possessing protective value against infection. These factors include sickle cell trait (HBAS) and sickle cell disease (HbSS) [3], ABO blood type [4] and the level of G-6-P-Dihydrogenase activity [5].

It is thought that an understanding of the nature of relationship (if any) between ABO blood groups and malaria parasitaemia would provide an invaluable window in the effort to contain the malaria scourge and that studies of malaria parasitemia from that stand point in populations of malaria endemic regions will be helpful in elucidating any such relationship [1].

Large numbers of severe malaria cases have been reported among blood group A individuals [6,7]. Furthermore, Migot-Nabias [8] and Pathirana et al. [9] observed low parasitaemia and uncomplicated malaria cases among blood group O individuals. Similarly, a significant advantage of *Plasmodium falciparum* with ABO blood groups with respect to group O has been reported by some authors [10,11,12]. Other studies have shown high frequency of malaria episodes among blood group A individuals as compared with other blood group individuals [13].

A number of studies were conducted to investigate the association between ABO blood group system and some disease conditions [14,15,16,17,18,19]. Some of these studies reported significant associations, suggesting that ABO blood groups have an impact on the infection status of the individuals possessing a particular ABO blood group [16,17,18,19].

Some studies reported the absence of significant association between *P. falciparum* (prevalence, parasitaemia or antibody titre) and ABO antigens [20,21,11]. Some other reports are however, less equivocal in relating malaria parasitaemia to ABO blood group [22,23]. Otajevwo [24] in a study associating malaria parasitaemia with ABO blood groups among residents of Warri, Nigeria, reported that 6.9%, 19.0%, 20.7% and 53.3% of a total of 174 whole blood samples processed belonged to blood groups AB, B, A and O. respectively and 138 (79.3%) of total sample size were infected with malaria parasites of which *P.*

*falciparum* was the predominant species. In the report, the highest malaria parasite load was observed among group O (52.2%) individuals while the least was noticed among blood group AB (8.7%) individuals. Malaria parasitaemia was higher among the males (83.3%) than females (75.0%).

Nkuo – Akenji et al. [25] determined the effects of ABO /Rhesus blood groups on malaria. They reported that the highest malaria prevalence rate of 74.5% was seen in group O individuals while the lowest (58.6%) was obtained for group B residents. They concluded that blood group O individuals may be more susceptible to malaria attack. A study conducted in Edo State University in Nigeria reported that blood groups O and B male individuals were the most and the least susceptible to malaria parasitaemia respectively [4].

Prevalence of malaria parasitemia and its possible association with ABO blood groups was investigated among inhabitants of Odakpu of Anambra State, Nigeria by Ilozumba and Uzozie [1]. They reported ABO blood group prevalence of 2.63%, 12.05%, 21.05% and 63.83% for groups AB, B, A and O respectively. According to their report, malaria parasitemia prevalence varied significantly ( $P < 0.05$ ) with blood groups and was highest (100.0%) in blood group AB. They concluded that ABO blood groups could be a factor that influences susceptibility to infection by *Plasmodium* species.

The distribution of ABO blood groups and their relationship with *Plasmodium falciparum* malaria among febrile 269 outpatients who sought medical attention at a health center in Southern Ethiopia was investigated by Zerihun et al. [26]. They reported that A, B and AB blood group individuals are more susceptible to *P. falciparum* infection compared to blood group O individuals. Despite the above researches, there is however, still lack of consensus on possible association between ABO blood group genes and malaria parasitaemia [27]. This might be due to limited data on the association between malaria and red blood cell ABO antigens [25]. Hence, results of more studies on ABO blood groups association with malaria parasitaemia in different parts of Nigeria and other neighboring countries would be needed before a more definite statement on the apparent trend could be made [1].

It is to further extend the frontiers of any possible association between malaria infection and ABO blood groups that this study aimed at investigating malaria parasitaemia association with ABO blood groups among students of Igbinedion University, Okada was carried out with the following objectives:

- a) Determine the ABO blood groups and Rhesus factor frequency distribution among students of Igbinedion University, Okada, Nigeria.
- b) Determine if there is a significant association of the ABO blood groups with malaria parasitaemia.
- c) Determine the sex distribution as related to ABO blood groups association with malaria parasitaemia.
- d) Determine if there is a significant association of ABO blood groups of male and female students separately with malaria parasitaemia.

## **2. MATERIALS AND METHODS**

### **2.1 Ethical Clearance**

Informed consent was given by students sampled as well as by the Department of Biological Sciences, Igbinedion University, Okada, Nigeria. Adult volunteering students were used for

the study. As incentive, students were promised free laboratory results of ABO blood grouping and malaria parasite tests. Sample size was not enough (as would have been required) due to the reluctance of a large number of students to give their consent owing to fear and suspicion. Students loudly expressed fear of pain of a needle or lancet blade. Others were suspicious of possibility of their blood samples being used for purposes other than those they were told

## 2.2 Sampling

Using sterile needle and syringes, two milliliters (2ml) of venous blood was collected from 104 randomly selected Igbinedion University, Okada students made of 24(23.1%) males and 80(76.8%) females. Blood samples which were collected by venipuncture (by tying a tourniquet around the upper arm and sterilizing arm with 70% ethanol to sterilize and increase blood pressure in the veins) were dispensed into ethylene- diamine-tetra-acetic acid (EDTA) anticoagulated blood containers, properly mixed by standard method and labeled appropriately. Subjects used were asymptomatic malaria parasite carriers. All symptomatic subjects were excluded from study. Symptomatic subjects were those whose malaria parasite tests were positive and showed obvious visible signs of illness.

## 2.3 Malaria Parasite Detection Test

The Malaria *Plasmodium falciparum* rapid Test Device (whole blood) package insert kit by Maconell [28] and Cookeetal [29] was used to test for presence of malaria parasite in the specimens.

## 2.4 Rapid Test Procedure

The test device, specimens, buffer and/or controls were allowed to equilibrate to 15-30°C (room temperature) prior to testing. The test device cassette was removed from the foil pouch and used immediately. Using the transfer dropper (provided), and held vertically one dropper of whole blood sample approximately 20µl (0.02ml) was transferred to the test tube. Added to this, were three full drops of buffer (approximately 120µl or 0.12ml) after which the mixture was allowed to stand for 1 minute. The test device (cassette) was placed on a clean and level surface. The test tube was squeezed five times to mix the specimen and buffer completely. The entire content (of about 140 µl) was then transferred to the specimen well in the cassette with the transfer dropper and the set up was left for 15-20 minutes.

## 2.5 Quality Control

Internal procedural controls were included in the test. A coloured line appearing in the control region (C) was used as an internal positive procedural control. The quality control was to confirm if sufficient specimen volume was used and if the correct procedural technique was applied.

## 2.6 Sensitivity of Test Device

The Malaria P. F Rapid test device (whole blood) has been tested in comparison with thick blood smears of clinical samples. The results show that the sensitivity of the test device (whole blood) is > 99% (greater than 99%) relative to blood smears.

## 2.7 Specificity

The test device uses an antibody that is highly specific for malaria *Plasmodium falciparum* antigen in the blood. The test device has a specificity of > 99.0% relative to blood smears.

## 2.8 Expected Values

The test device has been compared with traditional thick or thin blood smears microscopic analysis. The correlation between the two systems is >99%.

## 2.9 Limitation

The Test Device is for in-vitro diagnostic test use only. Neither the quantitative value nor the rate of increase in PF antigen concentration can be determined by its qualitative test. The Test Device will only indicate the presence of *Plasmodium falciparum* antigen and hence the Specimen should not be used as the sole criteria for the diagnosis of malaria infection. All results must be interpreted together with other clinical information available to the physician. A negative result does not any time preclude the possibility of malaria infection.

## 2.10 Giemsa Staining

This manual staining was carried out as quality control of the rapid test method. Thick blood films were made on grease free microscope slides (after appropriate labeling) and allowed to air dry on laboratory working bench. Slides were arranged on a staining rack and flooded with 10% (v/v) Giemsa Stain solution for 15 minutes [30]. Only positive results with the rapid test device and Giemsa staining method were recorded and used for ABO blood group typing.

## 2.11 Typing Blood Samples for ABO Blood Group Antigens

The ABO blood group of each subject was determined using cell grouping Antisera according to methods described by Rosenfield [31] and Cheesbrough [32]. Monoclonal Antisera A, B and D (Agappe Diagnostics Ltd, India) were used.

## 2.12 Statistical Analysis of Data

Chi square ( $\chi^2$ ) analysis using test of independence of two characters or associations using a 4x3 contingency table at 95% confidence interval was used. The software used was the statistical package for Social Sciences or SPSS version 17.0. Confidence interval at 95% (0.05) was calculated using: Mean  $\pm$   $t_{0.05 (6)}$   $S_x$  where 6 refers to degree of freedom calculated using (r-1) (c-1).

## 3. RESULTS

Presented in Table 1 are data representing ABO bloods group and Rhesus factor frequency distribution among students of Igbinedion University, Nigeria. A total of 104 students' blood samples made up of 24(23.1%) males and 80(76.8%) females were processed for ABO blood grouping. Out of this sample size, 24(23.1%) male samples were rhesus positive while 76(73.0%) female samples were rhesus positive. Only 4(3.9%) female samples were rhesus

negative. In terms of male ABO blood grouping, 4(3.9%), 8(7.7%) and 12(11.5%) male students were grouped into blood groups B, A and O respectively. There was no male AB group. With regards to the female students, 4(3.9%), 8(7.7%), 28(26.9%) and 40(38.4%) students were grouped into AB, A, B and O respectively.

**Table 1. ABO blood groups and rhesus factor frequency distribution among students of Igbinedion University, Okada, Nigeria**

ABO blood groups	Sex	Rhesus positive	Rhesus negative	Total
<b>A</b>	M	8(7.7%)	0.0%	8(7.7%)
	F	8(7.7%)	0.0%	8(7.7%)
<b>B</b>	M	4(3.9%)	0.0%	4(3.9%)
	F	24(23.1%)	4(3.9%)	28(26.9%)
<b>AB</b>	M	0.0%	0.0%	0.0%
	F	4(3.9%)	0.0%	4(3.9%)
<b>O</b>	M	12(11.5%)	0.0%	12(11.5%)
	F	40(38.4%)	0.0%	40(38.4%)
<b>Total</b>	M	24(23.1%)	0.0%	24(23.1%)
	F	76(73.0%)	4(3.9%)	80(76.8%)

Data on the association of ABO blood groups with malaria parasitaemia are presented in Table 2. A total of 4(3.9%), 16(15.4%), 32(30.8%) and 52(50.0%) students sampled belonged to blood groups AB, A, B and O respectively in that increasing order. From the highest to lowest, 40(38.4%) of the total blood group O individuals were infected with malaria trophozoites (parasites) of which 16(15.4%) students scored a density of (+) to (+++) while 24(23.1%) had scanty trophozoite parasites in their peripheral blood. The next group was blood group B of which 24(23.1%) students were infected. The least infected group was AB group with only 4(3.9%) infected individuals. Incidentally, all the 4(3.9%) AB students sampled were infected. On the whole, out of the 104(100.0%) sampled whole blood specimens, 80(76.8%) representing more than 50% were positive for malaria parasitaemia of which 28(26.9%) individuals scored malaria parasite densities of (+) to (+++) and 52(50.0%) had scanty parasites in their blood stream. There was a significant statistical association between malaria parasitaemia and ABO blood groups ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 13.663 and hence,  $P < 0.05$ ). There was also statistical significant association of malaria parasitaemia and ABO blood groups among female students ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 13.577 and hence,  $P < 0.05$ ). The association of malaria parasitaemia with ABO blood groups among male students was not significant ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 8.212 and  $P > 0.05$ ).

**Table 2. Association of ABO blood groups of Igbinedion University students, Okada with malaria parasitaemia**

ABO blood groups	Malaria parasite density test				Total malaria positive	Negative	Total
	+++	++	+	Scanty			
A	0.0%	0.0%	4(3.9%)	8(7.7%)	12(11.5%)	4(3.9%)	16(15.4%)
B	0.0%	0.0%	4(3.9%)	20(19.2%)	24(23.1%)	8(7.7%)	32(30.8%)
AB	0.0%	0.0%	4(3.9%)	0.0%	4(3.9%)	0.0%	4(3.9%)
O	4(3.9%)	4(3.9%)	8(7.7%)	24(23.1%)	40(38.4%)	12(11.5%)	52(50.0%)
TOTAL	4(3.9%)	4(3.9%)	20(19.2%)	52(50.0%)	80(76.8%)	24(23.1%)	104(100.0)

*Chi - square ( $X^2_{0.05, 6}$ ) = 12.592 (P or book value) calculated or critical value = 13.663  
 $P < 0.05$ .*

In Table 3, results on sex distribution as they relate to ABO blood groups' association with malaria parasite infection are presented. Out of the 104 (100.0%) sampled population, there were 24(23.1%) males and 80(76.8%) females of which 12(11.5%) of total sampled males representing 50%, were infected while 68(65.4%) out of the total sampled females representing more than 50%, were infected. Of the total male subjects, 0.0%, 4(3.9%), 8(7.7%) and 12(11.5%) students were grouped into AB, B, A and O blood groups respectively. There was no male AB blood group subject. There were more female students sampled of which 4(3.9%), 8(7.7%), 28(26.9%) and 40(38.4%) female students were placed into AB, A, B and O blood groups respectively in that ascending order. In group A male individuals, 4(3.9%) out of 8(7.7%) sampled were infected with malaria parasites. All 4(3.9%) group B male subjects sampled were infected with malaria parasites and there were no sampled male AB individuals. Out of 12(11.5%) sampled male blood group O individuals, 4(3.9%) were infected with malaria trophozoites. In blood group A, all the 8(7.7%) female blood samples were infected with malaria parasites and this was similar to the trend in the male subjects of the same group. Twenty (19.2%) out of 28(26.9%) sampled female blood group B students were infected with the parasite and like the case of blood group A, all the 4(3.9%) blood group AB female students were infected with the parasite. Lastly, in blood group O, 36(34.5%) female students were infected out of 40(38.4%) of the total sampled for the group.

**Table 3. Sex distribution as related to ABO blood group association with malaria parasitaemia**

ABO blood groups	Sex	Malaria parasite density test				Total malaria parasite positive (i.e. +++, ++,+ & Scanty)	Negative	Total
		+++	++	+	Scanty			
A	M	0.0%	0.0%	0.0%	4(3.9%)	(39%)	4(3.9%)	8(7.7%)
	F	0.0%	0.0%	4(3.9%)	4(3.9%)	8(7.7%)	0.0%	8(7.7%)
B	M	0.0%	0.0%	0.0%	4(3.9%)	4(3.9%)	0.0%	4(3.9%)
	F	0.0%	0.0%	4(3.9%)	16(15.4%)	20(19.2%)	8(7.7%)	28(26.9%)
AB	M	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	F	0.0%	0.0%	4(3.9%)	0.0%	4(3.9%)	0.0%	4(3.9%)
O	M	0.0%	0.0%	4(3.9%)	0.0%	4(3.9%)	8(7.7%)	12(11.5%)
	F	4(3.9%)	4(3.9%)	4(3.9%)	24(23.1%)	36(34.5%)	4(3.9%)	40(38.4%)
TOTAL	M	0.0%	0.0%	4(3.9%)	8(7.7%)	12(11.5%)	12(11.5%)	24(23.1%)
	F	4(3.9%)	4(3.9%)	16(15.4%)	44(42.3%)	68(65.4%)	12(11.5%)	80(76.8%)

Males:  $\chi^2_{0.05,6} = 12.592$  (P or Book value), calculated value = 8.212 (P>0.05), females: calculated value = 13.577 (P< 0.05).



#### 4. DISCUSSION

The ABO locus is associated with the serum levels of molecules known to bind to *P. falciparum* infected red blood cells that are also markers of damage to vascular endothelial cells and inflammatory processes [33,10,34]. Furthermore, parasitized red blood cells have a stronger tendency to form rosettes with uninfected erythrocytes of the A, B or AB blood groups than with those of blood group O [35].

Results obtained in this study showed that 4(3.9%), 16(15.4%), 32(30.8%) and 52(50.0%) of the 104 sampled subjects made up of 24(23.1%) male and 80(76.8%) female students, belonged to blood groups AB, A, and O respectively in that increasing order. These findings showed that the most prevalent blood group is O (50.0%) and the least, AB (3.9%). This was consistent with the report of Ilozumba and Uzozie [1] which stated blood group prevalence rates of 2.63%, 12.05%, 21.0% and 63.83% for AB, B, A and O respectively. Results in this study also differed from that of Otajevwo [24] which reported prevalence rates of Warri ABO blood groups of 12(6.9%), 33(19.0%), 36(20.7%) and 93(53.5%) for AB, B, A and O respectively. Findings in this work also differed from the report of Zerihun et al. [26] which recorded 3.3%, 21.9%, 23.5% and 51.3% for AB, B, A and O respectively.

Data obtained in this work also indicated that there were 24(23.1%) and 76(73.0%) male and female rhesus positive students respectively and whereas, there were no male rhesus negative individuals, a total of 4(3.9%) female rhesus negative students were recorded (Table 1). This confirmed that although the prevalence of rhesus negative factor in populations is small, the occurrence of 4(3.9%) out of a sample population of 104 may not be insignificant in view of the medical implications in terms of child birth and still birth arising from haemolytic disease of newborn (HDN).

Data obtained in this study also showed that the most prevalent blood group is group O because 52 students representing exactly 50.0% of the population sampled, belonged to that group. At the other extreme, the least occurring group was AB with 4(3.9%) students occurring in the group (Table 2). These findings are not consistent with an earlier study by Agbonlabor et al. [4] which reported groups O (51.9%) and A (11.0%) as the highest and least occurring respectively, but are in agreement with the reports of Zerihun et al. [26], Ilozumba and Uzozie [1] and Otajevwo [24]. These differences may be due to ethnic, racial and geographical differences of the various populations studied.

Results further revealed that 80(76.8%) of the 104 students sampled harboured malaria parasites of various densities. This rather high parasitaemia rate suggests that Okada town is hyperendemic for malaria. This parasitaemia rate appears to be low when compared to 93.4% obtained in Odoakpu, Onitsha South by Ilozumba and Uzozie [1]. Parasitaemia rate in this study appears high however, when related to prevalence rates of 79.3%, 77.4%, 58.3%, 43.2%, 10.0% and 6.0% obtained respectively for blood donors in Warri [24], Owerri [36], Children in Awka [37], coastal dwellers of Lagos State [38], blood donors in Ibadan [39] and blood donors in Maiduguri [40]. These results may suggest existence of regional differences in malaria parasitaemia in Nigeria with the midwestern and eastern areas (represented by Warri South LGA, Onitsha South LGA and Owerri) ranking highest in prevalence rating and the northern area (represented by Maiduguri) occupying the lowest position, while the Western area (represented by Lagos State and Ibadan takes a middle position [1]. The high prevalence rate in Warri may be due to the swampy nature of the terrain being a Niger Delta area of Nigeria as well as the densely populated nature of the area owing to its oil rich disposition [24]. Results of more studies on malaria parasitaemia in different parts of the

country would be needed before a more definite statement on the apparent trend could be made.

The somewhat high malaria parasitaemia rate recorded among Igbinedion University, Okada students in this study may be as a result of the unsanitary situation of the university environment (with weeds and unkept grass around classrooms) or the unsanitary situation in and around the students' hostels in terms of choked drainage channels, littering of empty cans, collection of pools of water etc which provide breeding grounds for anopheles mosquitoes (vectors of human *Plasmodium* species) which breed in diverse types of aquatic habitats [41]. Other likely pre-disposing factors in the area may include over-crowding in hostels which could facilitate vector-man contact, and malaria parasite transmission.

Out of 24(23.1%) male students screened 12(11.5%) were infected compared to 68(65.4%) female infected blood samples out of a total of 80 (76.8%) female samples processed. This clearly shows a much higher infection rate in female students in relation to their male counterparts. This report is not consistent with trends observed in Warri [24], Ekpoma [4], Odoakpu [1], Owerri [36] and the coastal areas of Lagos [38, 42]. The reasons for the observed gender differences are far-fetched and more studies on other populations in other parts of Nigeria would be expedient to offer possible explanation.

Data obtained in this study also showed that the highest malaria parasitaemia rate was observed in the O blood group with 40(38.4%) group O students showing various densities of *Plasmodium falciparum* parasites out of 52(50.0%) group O students screened. Again, this finding is in agreement with those of Otajevwo [24] and Nkuo-Akenji [25]. Ilozumba and Uzozie<sup>1</sup> recorded 100.0% malaria parasitaemia among blood group AB individuals followed by 94.9% among blood group O subjects and this is not consistent with findings of the present study. Findings in this study also disagree with reports of Migot-Nabias et al. [8] and Pathirana et al. [9] who observed low malaria parasitaemia among blood group O individuals. In their reports, they concluded that blood group O seems to confer a certain degree of protection against severe courses of the disease.

It is note-worthy that blood group A subjects appeared to record a high parasitaemia rate of 12(11.5%) out of a total of 16(15.4%) sampled in the group. Parasitaemia rates of 24(23.1%) out of 32(30.8%) and 4(3.9%) out of 4(3.9%) for blood groups B and AB respectively also appear to be high relative to each other. Although a study using larger sample size would be required to validate this finding, it seems there is relative spread of malaria parasitaemia across all blood groups in this study. This is consistent with findings from a study carried by Fischer and Boone<sup>6</sup> of which they reported that malaria occurs in patients of any blood group and that no particular blood group precludes the possibility of severe malaria.

An equal number of male and female students occurred in blood group A. In group B, 28(26.9%) female students occurred compared to 4(3.9%) male students. This somewhat suggests that there are more females in group B when compared with male blood group B individuals. Whereas there were no male AB individuals, all the 4(3.9%) screened were females. Ostensibly maintaining the earlier trends (apart from group A), more than 75% of the female students occurred in group O compared with the males. The gender trend seems to erroneously suggest that more female individuals in Igbinedion University, Okada occurred in each blood group. This cannot be conclusive as it may have occurred by chance. The picture may become clearer and more acceptable if a similar study with a much higher sample size is carried out possibly using the same study area.

Also going by sex distribution of malaria parasitaemia, results revealed that much more female students were infected with malaria parasites compared to the male students. This does not tally with the suggestion of Portilo and Sullivan [43] that genetic factors could play a role by endowing females with immuno-regulatory potentials to cope better with some diseases. Again, the occurrence of a higher malaria parasitaemia rate among the female students across all blood groups (Table 3) may be a matter of chance. This, too, is subject to experimental re-evaluation by some other researchers.

There was a significant statistical association between malaria parasitaemia and ABO blood groups ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 13.663 and hence,  $P < 0.05$ ). This significant association is in line with the report of Zerihun et al. [26] and is inconsistent with findings of Nkuo-Akenji [25], Kassim et al. [15], Thakur and Verma [44], Montoya et al. [45] and Uneke et al. [20]. There was also statistical significant association of malaria parasitaemia and ABO blood groups among female students ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 13.577 and hence,  $P < 0.05$ ). The association of malaria parasitaemia with ABO blood groups among male students was not significant ( $X^2_{0.05, 6} = 12.592$ , calculated value at 95% C.I = 8.212 and  $P > 0.05$ ).

## **5. CONCLUSION**

In conclusion, this study further confirms that in any given population, the highest number of subjects belong to ABO blood group O while the least number belong to group AB. Besides, more than 75% of female students sampled occurred in ABO group O and the highest malaria parasitaemia rate was observed among group O individuals. There was also a higher malaria parasitaemia rate among the female students compared to the male students. In all, there was a relative spread of malaria parasites across all blood groups.

There was a statistical significant association of malaria parasitaemia and ABO blood groups among all students sampled and this association may be due to the significant association that occurred among the female students as shown by statistics. It is recommended that findings in this study should be reviewed using much larger sample size. The practical implication of findings in this study is that based on the statistical insignificant association of malaria infection with ABO blood groups of sampled subjects generally, both males and females of ABO blood groups A, B, AB and O are equally at risk under any given circumstance. Consequently, available malaria prophylactic and therapeutic strategies by health agencies should be directed at individuals of all groups without any discrimination or preference for a particular group.

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## **COMPETING INTERESTS**

Author has declared that no competing interests exist.

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