*International Journal of TROPICAL DISEASE & Health*
*17(1): 1-8, 2016, Article no.IJTDH.24293*
*ISSN: 2278–1005, NLM ID: 101632866*

**SCIENCEDOMAIN *international***
*www.sciencedomain.org*

# Prevalence of ABO Blood Groups and Its Relationship with Malaria Parasitemia among Students of Federal University of Technology, Akure, Ondo State

**I. A. Simon-Oke[1*], O. J. Afolabi[1] and A. I. Itansanmi[1]**

*[1]Department of Biology, Federal University of Technology Akure, Ondo State, Nigeria.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/IJTDH/2016/24293
Editor(s):
(1) Thomas I Nathaniel, Department of Biomedical Sciences, School of Medicine –Greenville, University of South Carolina, Greenville, USA.
(2) Shankar Srinivasan, Department of Health Informatics, University of Medicine & Dentistry of New Jersey, USA.
(3) William Ebomoyi, Department of Health Studies, College of Health Sciences, Chicago State University, USA.
Reviewers:
(1) Paulo Adão De Campos, Agostinho Neto University, Angola.
(2) Aristóteles Comte de Alencar Filho, Amazonas University, Brazil.
(3) Francis W. Hombhanje, Divine Word University, Papua New Guinea.
(4) Anonymous, Nigerian Institute of Medical Research, Nigeria.
(5) Samar al Nahhas, Damascus University, Syria.
Complete Peer review History: http://sciencedomain.org/review-history/14582

***Original Research Article***

***Received 12th January 2016***
***Accepted 21st March 2016***
***Published 12th May 2016***

## ABSTRACT

There are different reports on the increasing evidence about the relationship between *Plasmodium falciparum* malaria and ABO blood group, but the range is yet to be understood. The aim of the study was to investigate the prevalence of malaria parasite and its relationship with ABO blood and rhesus grouping among newly admitted students of FUTA. Two millilitres (2 ml) of venous blood was collected by venipuncture using 5 ml hypodermic needles and syringes from 312 symptomatic and asymptomatic malaria students. 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 312 samples analysed were made up of 126 (40.4%) rhesus positive and 10(3.21%) rhesus negative. In

**Corresponding author: Email: adepejuolayemi@yahoo.com;*

decreasing order, 60.0%, 45.3%,39.1% and 37.3% students occurred in blood group AB, O, A and B respectively. On the whole, 136(43.6%) of total samples processed, were positive for malaria parasitaemia out of which *Plasmodium falciparum* account for 82(60.3%). 97(46.2%) and 39(38.2%) 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 more susceptible to malaria infection. There was no significant difference in age group and sex (P>0.05) of the subjects while there was a significant difference in prevalence of malaria parasite and blood groups (P<0.05).

*Keywords: Malaria; parasite; relationship; blood group; Rhesus factor; genotype.*

## 1. INTRODUCTION

Malaria is a parasitic disease caused by protozoan of the phylum *Apicomplexa*, class *sporozoasida*and subclass *coccidian*. It is vectored by infected female *Anopheles* mosquitoes. The infective sporozoite in their salivary gland is transmitted to human during blood feeding. Malaria is one of the most severe public health problems and a leading cause of death in many developing countries especially Africa. According to World Malaria Report [1] the number of annual cases worldwide is actually decreasing, yet the impact of the disease burdens remain an enormous challenge and a threat to human life. Individuals with less immunity are at most risk from the disease. These include young children, pregnant mothers, travellers and people from endemic areas who are not regularly exposed to infection [2].

*Plasmodium* infection has long been identified as a main public health problem in the tropical and subtropical countries [3]. 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), ABO blood type and the level of G-6-P-Dihydrogenase activity [4]. Malaria parasites are known to respond differently to their environment in the human host such as the structure of haemoglobin [2]. Malaria parasite does not thrive well in sickle cell individuals; this natural protection has made the haemoglobin 'S' gene resilient in malaria-infested areas, particularly Africa. The protection against malaria is bestowed only on people who have sickle cell trait and have inherited just a single gene because haemoglobin 'S' is known to interfere with the growth and reproduction of malaria parasite [5,6].

The blood grouping system consists of the A, B and H carbohydrate antigens, which can regulate protein activities during infection and antibodies against these antigens [7]. ABO blood grouping is based on the presence or absence of A and B blood group antigens on the surface of red blood cells (RBC) derived from inherited gene [8]. It has been the most important selective force on the human population. Variations in reports on the association of ABO blood groups and disease progression of malaria show the complexity of the interaction between the parasite and host immune responses. There is a hypothesis that *Plasmodium falciparum* malaria has shaped the distribution of ABO blood groups in humans [8]. It is thought that an understanding of the nature of relationship between ABO blood groups and malaria parasite would provide an invaluable window in the effort to contain the malaria scourge and that studies of malaria parasite from that stand point in populations of malaria endemic regions will be helpful in elucidating any such relationship [4].

The Objectives of the study is to;

Determine the ABO blood group and Rhesus factor frequency distribution among the newly admitted students of FUTA.

Determine if there is a significant relationship of the ABO blood groups with malaria parasites.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was conducted at the Federal University of Technology Akure, (FUTA) Ondo State. Akure is the capital and the largest city of Ondo State which covers a land area of 14,793 square kilometers within south-west of Nigeria. It lies between latitude 7°15'0''N and longitude 5°11'42''E and has a population of about

484,798. Akure, has an average temperature of 25.6℃ and relative humidity of 85% [9].

## 2.2 Ethical Clearance

Prior to the commencement of the research, relevant approval was obtained from the University Ethical Review Committee and an introduction letter was given by the Department of Biology to the Chief Medical Director of the University Health Centre. Informed consent was sought from the students before samples were collected from them.

## 2.3 Sample Collection

Using sterile needle and syringes, two millimetres (2 ml) of venous blood was collected from the subjects with the assistance of the Laboratory technologists by vein puncture technique. Blood collected were dispensed into ethylene- diamine-tetra-acetic acid (EDTA) anticoagulated blood containers, properly mixed and labelled appropriately. Relevant data including department, age and gender were obtained from the respondents at the end of collection to aid the epidemiological studies.

## 2.4 Laboratory Analysis

Thick and thin films were prepared on the same clean and grease free slide after appropriate labelling and allowed to air dry on laboratory working bench. Thin films were fixed with methanol and allowed to evaporate while the thick films were not fixed with methanol. Slides were arranged on a staining rack and flooded with 10% Giemsa Stain solution for 10-15 minutes. The stain was washed under a slow flowing tap water and allowed to air dry. Finally, the films were carefully examined under oil immersion microscope objective (x100). Parasitemia was calculated per 200 White blood cells [10].

## 2.5 Blood Group and Rhesus Test

The ABO blood group of each subject was determined using cell grouping Antisera (A, B and D). Three (3) drops of each subject blood sample is placed on separate points on a sterile white tiles divided into three (3) cells. A drop of antisera A, B and D were placed beside the blood and thoroughly mixed to obtain a homogenous mixture with the aid of a sterile rod and the tile was rocked gently to ensure uniform mixing. The mixtures were carefully observed to determine blood group of students by the presence of agglutination or not. Antiserum D was used to determine the Rhesus factor. Finally the blood samples of respondents were grouped based on these observation and confirmation into blood group $A^+$,$A^-$,$B^+$,$B^-$,$AB^+$,$AB^-$,$O^+$ and $O^-$.

## 2.6 Data Analysis

Data obtained were subjected to Chi-square test and ANOVA (SPSS version 20) to assess the difference between frequencies (the relationships between blood groups and *Plasmodium species*) and analysed at 95% level of significance. Observed difference was considered to be significant for $p < 0.05$.

$$\text{Prevalence} = \frac{\text{Number of infected individual}}{\text{Total number of examined individual}} \times 100$$

## 3. RESULTS

Table 1 shows the demographic characteristics of the sampled population. The age group of the sampled population ranged from 16-30 years. Most of the subjects 67.3% (210) were males, while 32.7% (102) were females. The distribution of the various ABO blood group were 46(14.7%), 59(18.9%), 15(4.8%) and 192(61.5%) for A, B, AB and O respectively. 288(92.3%) of the subjects were rhesus D positive; while only 24(7.7%) of them were rhesus D negative.

A total of 312 blood samples were sampled, out of which 192(61.5%) males and 96(30.8%) females were rhesus positive and 18(5.8%) males and 6(1.9%) females were rhesus negative. 29(9.3%), 43(13.8%), 10(3.2%) and 128(41.0%) male students were grouped into blood groups A, B, AB and O respectively. For the females, 17(5.4%), 16(5.1%), 5(1.6%) and 64(20.5%) were grouped into A, B, AB and O respectively (Table 2).

The data on the relationship of ABO blood groups with malaria parasitaemia are presented in Table 3. Out of the 312(100.0%) students sampled, 136(43.6%) were positive for malaria parasitaemia. AB individuals 9(60.0%) were infected with malaria parasites with geometric mean density value of 3.02 in their peripheral blood, blood group O with 87(45.3%) and a mean density value of 3.99. The least infected was group B with only 22(37.3%). Statistical analysis showed significant association in malaria parasitaemia and ABO blood groups ($P=0.006$, $P<0.05$).

**Table 1. Demographic characteristic of the study subjects**

| Parameters | Number (%) |
|---|---|
| **Age** | |
| 16-20 | 146(50.7) |
| 21-25 | 147(37.4) |
| 26-30 | 19(36.8) |
| **ABO** | |
| A | 46(14.7) |
| B | 59(18.9) |
| AB | 15(4.8) |
| O | 192(61.5) |
| **Rhesus factor** | |
| Rh positive | 288(92.3) |
| Rh negative | 24(7.7) |
| **Gender** | |
| Male | 210(67.3) |
| Female | 102(32.7) |

Table 4 shows the data obtained on sex distribution as they relate to ABO blood groups' association with malaria parasite infection. Out of the 312(100.0%) sampled population, 97(46.2%) males and 39(38.2%) females were positive for malaria infection. Of the infected male subjects, 13(13.4%), 15(15.5%), 8(8.2%) and 61(62.8%) were of blood group A, B, AB and O respectively. For females, 5(12.8%), 7(17.9%), 1(2.6%) and 26(66.7%) fell into group A, B, AB and O respectively. The association of malaria parasite with ABO blood groups among gender was not statistically significant ($X^{2=}$1.767, P=0.184, P>0.05).

The prevalence of malaria parasite within age-group is summarized in Fig. 1. The age group of 16-20 years recorded the highest prevalence rate (50.7%), the age-group with the least prevalence rate (36.8%) were subjects of 26-30 years. Statistical analysis showed no significant difference in malaria infection and age-group ($X^2$=5.62, P=0.06, P>0.05)

Table 5 shows that out of 136 positive cases, 82(60.3%), 34(25.0%) and 20(14.7%) blood samples were parasitized with *P. falciparum*, *P. vivax* and *P. malariae* respectively.

## 4. DISCUSSION

This study showed that the most prevalent blood group is O 192 (61.5%) and the least is AB 15(4.8%), this is consistent with the reports of [11,2]. This might be as result that ABO blood group is known to exhibit racial patterns [12,4]. 192(61.5%) males and 96(30.8%) females were rhesus positive while 18(5.8%) males and 6(1.9%) females were rhesus negative. This confirmed that the occurrence of rhesus factor negative even when minimal, may not be insignificant considering the medical implications in terms of child birth and still birth, arising from haemolytic disease of newborn [4].

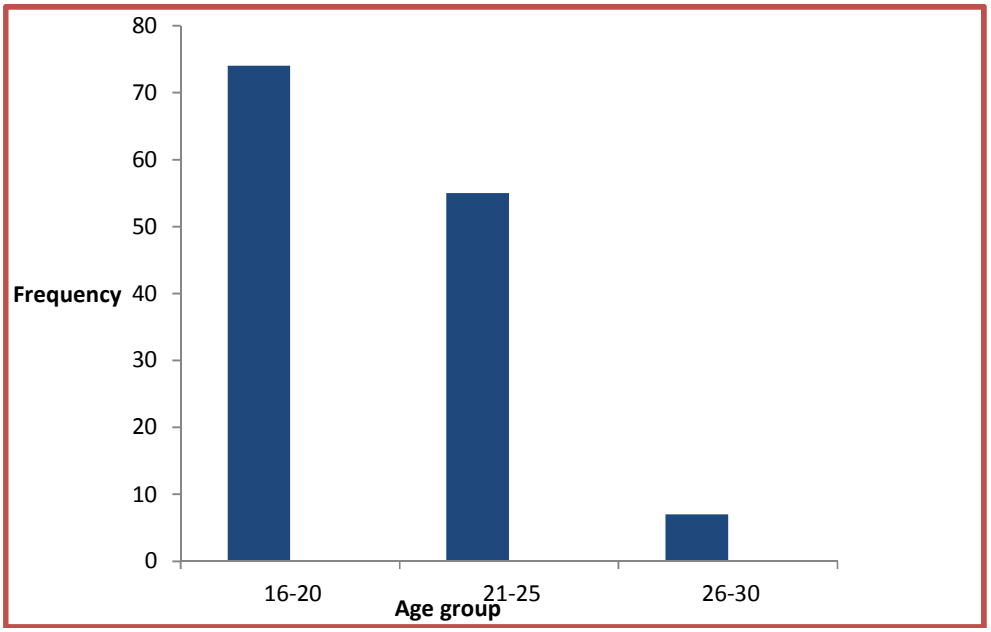


**Fig. 1. Prevalence of malaria within age group**

**Table 2. ABO blood group and rhesus factor distribution**

| Blood group | Gender | Rhesus positive (%) | Rhesus negative (%) | Total (%) |
|---|---|---|---|---|
| A | M | 28(9.7) | 1(4.2) | 29(9.3) |
| | F | 16(5.6) | 1(4.2) | 17(5.4) |
| B | M | 40(20.8) | 3(12.5) | 43(13.8) |
| | F | 15(15.6) | 1(4.2) | 16(5.1) |
| AB | M | 9(3.1) | 1(4.2) | 10(3.2) |
| | F | 5(1.7) | 0(0.0) | 5(1.6) |
| O | M | 115(39.9) | 13(54.2) | 128(41.0) |
| | F | 60(20.8) | 4(16.7) | 64(20.5) |
| Total | M | 192(61.5) | 18(5.8) | |
| | F | 96(30.8) | 6(1.9) | |

**Table 3. Association of ABO blood group with malaria parasite**

| Blood group | Number examined | Number positive (%) | Mean density (par/µL of blood) |
|---|---|---|---|
| A | 46 | 18(39.1) | 4.29 |
| B | 59 | 22(37.2) | 3.51 |
| AB | 15 | 9(60.0) | 3.02 |
| O | 192 | 87 (45.3) | 3.09 |

*(P= 0.006, P<0.05)*

**Table 4. Sex distribution as related to ABO blood group association with malaria parasite**

| Blood group | Gender | Number positive (%) |
|---|---|---|
| A | M | 13(13.4) |
| | F | 5(12.8) |
| B | M | 15(15.5) |
| | F | 7(17.9) |
| AB | M | 8(8.2) |
| | F | 1(2.6) |
| O | M | 61(62.8) |
| | F | 26(66.7) |
| Total | M | 97(46.2) |
| | F | 39(38.2) |

*($X^2$=1.767, P=0.184, P>0.05)*

**Table 5. Distribution of *Plasmodium* species among infected subjects**

| *Plasmodium* species | Number examined | Number infected (%) |
|---|---|---|
| *P. falciparum* | 136 | 82(60.3) |
| *P. vivax* | 136 | 34(25.0) |
| *P. malariae* | 136 | 20(14.7) |

Parasitemia seemed to be relatively high across a blood group with group AB and B subjects recording the highest and the least infection rates. Subjects with O blood group occur most but the prevalence of malaria parasites was highest among those with AB blood group (60.0%) and lowest in those with B blood group (37.2%) which is similar to the findings of [13]. These differences may be due to ethnic, racial and geographical differences of the population studied. 136(43.6%) of the 312 students sampled harboured malaria parasites of various densities which suggests meso-endemicity of malaria parasite infection in the study area according to [14] standard for classification of endemicity. However, the result is different from the prevalence rate (45.8%) reported by [15]. This result shows that the prevalence of malaria is still relatively high among the students in the study area as value obtained are relatively close. This might be an indication that the students are exposed to mosquito bites which may be as a result of unsanitary condition of the environment and exposure to mosquito at one point or the other. [3] reported that inadequate use of mosquito nets and insecticides could also be a predisposing factor. Other likely pre-disposing factors in the area may include over-crowding in hostels which could facilitate vector-man contact, and malaria parasite transmission [4].

Blood group AB subjects appeared to record a high parasitaemia rate of 9(60.0%) out of a total of 15(4.8%) sampled in the group. Parasitaemia rates of 22(37.2%) out of 59(18.9%) and 18(39.1%) out of 46(14.7%) for blood groups B and A respectively also appear to be high relative to each other. 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 [16] 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.

Gender specific prevalence showed that male and female students were equally at risk of getting infected (Table 4). However, disease prevalence was slightly higher in male (46.2%) than female (38.2%). This correlates with the work of [17,18] where males had a higher malaria parasite infection rate than females. The present study was, however, in contrast to that of [19,4] which reported more females being infected than males. This higher prevalence of *Plasmodium* infection in males than females recorded in this work, could be due to the fact that males expose their bodies more often than the females and thus increases their chances of being bitten by the mosquito [20].

Blood group AB was more significantly infected with malaria parasites than other blood groups. This is similar with the reports of [11,21] who reported highest malaria parasitaemia in blood group AB individuals. This significant association is an indication that malaria susceptibility may be ABO blood group dependent as suggested by [22,23] The lack of antibodies in the serum of AB blood group could be implicated in their susceptibility to infection.

This study also revealed that malaria parasitaemia could be age-related. A progressive increase in prevalence was observed as the age increased. This correlates with the results of some earlier studies in Nigeria [24,25,18]. Prevalence of malaria parasitaemia was highest (50.7%) in the 16-20 years age group and declined in older groups. A similar trend was observed in the findings of [26] who recorded predominant infection rate in adolescents. [27] and [20] reported that the degree of immunity is related to the duration of exposure to *Plasmodium* species which is longer for older persons.

This work revealed that *Plasmodium falciparum* was the highest of the species responsible for malaria infection. This is in accordance with the findings of [2,28,29]. This high rate could be due to the availability of mosquito vectors for the transmission of infection and suitable environmental conditions for the multiplication of *P. falciparum*. The low rate of other *Plasmodium* species may be because they tend to be selective in the type of blood cells they infect. *P. malariae* and *P. ovale* prefers leucocytes and young red blood cells than the old blood cells [30].

## 5. CONCLUSION

The high prevalence of malaria parasitaemia encountered, establishes that socioeconomic factors, such as appalling sanitary condition, low standard of living, inadequate use of treated mosquito nets are still very much in play as a predisposing factor to malaria infection in the study area. Based on the statistical significant relationship of malaria infection with ABO blood groups of sampled subjects, 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 Government and Non-Governmental health agencies should be directed at individuals of all groups without any discrimination or preference for a particular group. Also, there is need for the government to incorporate control programs such as public enlightenment, free intense distribution of Insecticide Treated Nets (ITNs) and tools that will give prompt and correct diagnosis of malaria parasites which will help reduce morbidity and mortality of the disease.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. WHO. Global Malaria program. World Health Organisation. World Malaria report; 2009.
2. Tidi SK, Amos JT, Firyanda E. Association between plasmodium infection, haemoglobin genotypes and blood groups among under-five nomadic fulani of Northeastern, Nigeria. International Journal of Malaria Research and Reviews. 2013; 1(2):7-11.
3. Agbolade OM, Akinmoladun A, Abimbola WA, Raufu ST, Atanda OM, Akinyemi SF. Parasitaemia among patients and blood donors in Ijebu-north, Southwest Nigeria. Asian Journal of Biological and Life Sciences. 2013;2(1):38-41.
4. Otajevwo FD. Prevalence of malaria parasitaemia and its association with ABO Blood grouping among students of igbinedion. University Okada, Nigeria.

British Journal of Medicine & Medical Research. 2013;3(4):1164-1177.
5. Goldfarb DM, Gaboury I, Dayneka N, Saux NL. Protocol for management of imported paediatric malaria decreases time to medication administration. Lancet. 2009;28(9):810-813.
6. Aidoo M, Terlouw DJ, Kolczak MS, McElory PD, Terkuile FO, Kariuki S, Nahlen BL, Lal AA, Udhayakumar V. Protective effect of the sickle cell gene against malaria morbidity and mortality. Lancet. 2009;359:1311-1312.
7. Gayathri BN, Harendra KML, Gomathi N, Shetty J, Reethesh RP. Relationship between ABO blood groups and malaria with clinical outcome in rural area of South India. Global Journal of Medicine and Public Health. 2013;2(2):1-7.
8. Tadesse H, Tadesse K. Assessing the association of severe malaria infection and ABO blood groups in Northwestern Ethiopia. Biomedical Institute, College of Health Science, Mekele University, Mekele; 2 Department of Microbiology, Immunology and Parasitology (DMIP), School of Medicine, Addis Ababa University, Addis Ababa, Ethiopia. 2013; 292–296.
9. Eludoyin OM, Elu AO. Temperature and relative humidity distributions in medium size administrative town in Southwest, Nigeria. Journal of Enviromental Management. 2007;87(1):95-105.
10. Cheesebrough M. District laboratory practice in tropical countries Cambridge. Cambridge University Press; 1998.
11. Ilozumba PCO, Uzozie CR. Prevalence of malaria parasitaemia and its association with ABO Blood group in Odoakpu area of Onitsha south local government area, Anambra state, Nigeria. Nigerian Annals of Natural Sciences. 2009;8(2):1–8.
12. Bray JB, Cragg PA, Macknight ADC, Mills RG. Lecture notes in human physiology. 4thEdition. Blackwell Science Ltd., Oxford. 1999;610.
13. Sule HA, Idachaba SO, Idoko T. Susceptibility of human of the ABO Blood groups to *P. falciparum* infection among patients attending Ahmadu Bello University Clinic (Sickbay), Samaru-Zaria, Kaduna State, Nigeria. Sch. Journal of Applied Medical Sciences. 2014;2(4C):1305-1309.
14. World Health Organization. Epidemiology of malaria. Malaria Roll back report; 2002.
15. Afolabi OJ, Simon-Oke IA, Sorungbe AA, Alao OO. Prevalence of malaria among biological science students in Federal University of Technology Akure, Nigeria. Nature and Science. 2015;13(2):10.
16. Fischer PR, Boone P. Short report: Severe malaria associated with blood group. American Journal of Tropical Medicine and Hygiene. 1998;58:122-123.7.
17. Bonilla E, Rodriguez A. Determining malaria effects in rural Colombia. Social Science and Medicine. 1993;37(9):1,109-14.
18. Muntaka S, Opoku-Okrah C. The Prevalence of malaria parasitaemia and predisposition of ABO blood groups to *Plasmodium falciparum* malaria among blood donors at a Ghanaian Hospital. Department of Immunology, School of Molecular Medical Sciences University of Nottingham, Nottingham, England, UK. African Union Journal of Technology. 2013;16(4):255-260.
19. Vlassoff C, Bonilla A. Gender related differences in the impact of tropical disease on women: What do we know? Journal of Biosocial Sciences. 1994; 26(1):37-53.
20. Akanbi OM, Badaki JA, Adeniran OY, Olotu OO. Effect of blood group and demographic characteristics on malaria infection, oxidative stress and haemoglobin Levels in South Western Nigeria. African Journal of Microbiology Research. 2010; 4(9):877-880.
21. Wolofsky K. The ABO polymorphism and *Plasmodium falciparum* malaria. In: A thesis submitted in conformity with the requirements for the degree of Master of Science; Graduate Department of Institute of Medical Sciences, Department of Medicine University of Toronto. 2009;1-103.
22. Hill AVS, Elvin J, Wills A. Molecular analysis of the association of HLA-B53 and resistance to severe malaria. Nature. 1992; 360:434-439.
23. Ademowo OG, Falusi AG, Mewoyeka OO. Prevalence of asymptomatic Malaria parasitaemia in Urban and rural communities in South Western Nigeria.
24. Central Africa Journal of Medicine. 1995;41:18-21.
25. Coker HAB, Chukwuani CM, Ifudu NO, Aina BA. The malaria scourge concept in disease management. Journal of Pharmacy. 2001;32-19-49.

26. Nebe OJ, Adeboye GO, Agono PU. Prevalence and clinical profile of malaria among the coastal dwellers of Lagos State, Nigeria. Nigerian Journal of Parasitology. 2002;23:61-68.
27. Alli JA, Okonkwo IO, Abraham OA, Kolade AF, Ogunjobi PN, Salako AO, Ojezele MO, Nwanze JC. A serosurvey of blood parasite (plasmodium, microfilariae, HIV, HBSAG, HCV antibodies) in prospective. Nigerian blood donors. Research Journal of Medical Sciences. 2010;4(4):255-275.
28. Brooks GF, Butel JS, Morse SA. Medical parasitology; 23rd edition. The McGraw-Hill Companies, Inc., Boston. 2004;818.
29. Aliu SH, Onojo IS, Idoko T. Susceptibility of humans of the ABO blood groups to *P. falciparum* infection among patients Attending Ahmadu Bello University Clinic (Sickbay), Samaru-Zaria, Kaduna State, Nigeria. Scholars Journal of Applied Medical Sciences. 2014;2(4C):1305-1309.
30. Singh G, Eureka AD, Singh R. A study on correlation of malaria infection with ABO RH blood system. Journal of Parasitology and Vector Biology. 2015;7(4):67-73.
31. Akanbi OM, Odaibo AB, Ademowo OG. Anti-MSP1 (19) antibody (IgG) and Reactive Oxygen Species (ROS) response against Malaria infection in Pregnancy in South western Nigeria. Asian Pacific Journal Tropical Medicine, 2009;2:9-15.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*http://sciencedomain.org/review-history/14582*