Short Communication

Asymptomatic Malaria among Blood Donors in Benin City Nigeria

*Bankole Henry OLADEINDE 1, Richard OMOREGIE 2, Eguagie Osarenio OSAKUE 3, Tola Ohiengbomwan ONAIWU 4

1. Dept. of Medical Microbiology, College of Health Sciences, Igbinedion University, Okada, Nigeria
2. School of Medical Laboratory Sciences, University of Benin Teaching Hospital, P.M.B 1111, Benin City, Nigeria
3. Dept. of Pathology, Igbinedion University Teaching Hospital, Okada, Nigeria
4. Luli Medical Laboratories, Benin City, Nigeria

Abstract

**Background:** This study aimed at determining the prevalence and associated risk factors for asymptomatic malaria parasitaemia and anemia among blood donors in a private medical laboratory in Benin City, Nigeria.

**Methods:** Venous blood was collected from a total of 247 blood donors. Malaria status, ABO, Rhesus blood groups and hemoglobin concentration of all participants were determined using standard methods.

**Results:** The prevalence of asymptomatic malaria infection was higher among commercial blood donors than volunteer group (commercial vs. volunteer donor: 27.5 % vs. 13.8%; OR = 2.373, 95% CI = 0.793, 7.107, P = 0.174). Asymptomatic malaria was not significantly affected by gender (P = 0.733), age (P = 0.581), ABO (P = 0.433) and rhesus blood groups (P = 0.806) of blood donors. Age was observed to significantly (P = 0.015) affect malaria parasite density with donors within the age group of 21-26 years having the highest risk. The prevalence of anemia was significantly higher among commercial donors (commercial vs. volunteer donors: 23.4% vs. 3.4%; OR = 8.551, 95% CI = 1.135, 64.437, P = 0.013) and donors of blood group O type (P <= 0.0001).

**Conclusions:** Asymptomatic malaria parasitaemia and anemia was higher among commercial donors than voluntary donors. Mandatory screening of blood donors for malaria parasite is advocated to curb transfusion transmitted malaria and associated sequelae.

Keywords: Asymptomatic malaria, Anemia, Blood donors, Private laboratory, Nigeria

*Correspondence Email: bamenz@yahoo.com

Received 20 Feb 2014
Accepted 14 Jun 2014

Available at: http://ijpa.tums.ac.ir
Introduction

Malaria is a leading cause of morbidity and mortality worldwide, affecting people of all age groups. Recent reports from the World Health Organization (WHO) indicate that, there were approximately 219 million cases of malaria in 2010 and an estimated 660,000 occurring mostly among African children (1). The prevalence of malaria in the world varies markedly from region to region. Nigeria accounts for a quarter of all malaria cases in the 45 malaria endemic countries in Africa (2).

Blood transfusion is a rapid and effective therapeutic intervention used widely for persons with life threatening anemia, often caused by malaria, malnutrition and a host of other factors. Blood donors can be divided into two broad groups: paid and unpaid, the latter commonly referred to as voluntary donors. Due to the endemicity of infectious diseases associated with blood loss in sub-Saharan Africa, the demand of blood for transfusion cases is high (3), and often in critical shortage. International policies recommend that blood be screened for malaria parasite prior to transfusion (4). Sadly, this is not done routinely in Nigeria, as in most countries in sub-Saharan Africa (5). Emphasis is often placed on screening for the human immunodeficiency virus (HIV), while paying little or no attention to the effect of transfusion transmitted malaria.

When malaria is transmitted through blood transfusion to a non-immune recipient, it can be rapidly fatal (6). Although, reports shows that a good number of recipients of blood transfusion living in malaria-endemic areas in sub-Saharan Africa are semi-immune to malaria (7), the degree of protection that this immunity confers against transfusion-transmitted malaria is unknown. Malaria due to Plasmodium falciparum can be acquired even with transfusion of a small number of infected red blood cells (8). Children and pregnant women, who form the bulk of recipients of blood in sub-Saharan Africa, are more likely to be immunologically compromised (6), thus exposing them to complications of transfusion-transmitted malaria. Hemoglobin assessment is an important criterion for blood donor selection. This is critical for the safety of blood donor and recipient. A number of African studies have reported that low hemoglobin concentration is frequent in most blood donors (9-11). This has great implication for the rate of recovery of patients transfused with blood.

In Nigeria, health care system comprises both public and private health facilities (12). The choice of healthcare facility patronized by an individual is largely determined by his/her taste, satisfaction with service and the perceived quality of care provided (12), among other factors. Although studies exist on prevalence of malaria parasitaemia among blood donors in Nigeria, none have focused on blood donors in non-public health care facilities in Edo State, Nigeria. Against this background, this study aimed at determining the prevalence and associated risk factors for asymptomatic malaria infection and anemia among blood donors in a private medical laboratory in Benin City, Nigeria.

Materials and Methods

Study center

This study was conducted from December 2011 to March 2013 in a government approved private medical laboratory outfit in Benin City, Nigeria.

Study population

A total of 247 apparently healthy blood donors consisting of 236 males and 11 females were recruited for this study. The age range of the study participants were 15 – 46 years. The prospective blood donor should appear generally well and should not be febrile, breathless, or suffering from a persistent cough (13). In malaria endemic regions, prospective blood
donors with fever and rigors should be exempted from donation (13). All study participants appeared generally well and did not present with fever and/or rigors. Informed consent was obtained from all participating subjects prior to specimen collection.

The study was approved by the Ethical Committee of Edo State Ministry of Health and the owner of the private medical laboratory used.

**Collection and processing of samples**

Five milliliters of blood were collected from all participants and were dispensed into ethylene diamine tetra-acetic acid (EDTA) containers and mixed. ABO and rhesus blood group were determined as previously described (14). Briefly, a drop of each participant’s blood was placed on three separate areas on a clean white tile. Each drop of blood was mixed with a drop of commercially prepared antiserum A, B and D respectively and observed for agglutination. Malaria was diagnosed by examination of stained thick blood films as previously described (15). Briefly, thick and thin films were made from each blood specimen and stained in 3% Giemsa stain for 30 minutes. The films were examined using oil immersion lens and a total of 200 fields per film were examined. The parasite density was calculated from Giemsa stained thick films by multiplying the ratio of number of malaria parasite to 200 white blood cells by an assumed total white blood cell count of 5000 cells/µL to give malaria density in cells/µL.

Hemoglobin estimation was determined using an auto-analyzer - Sysmex KX-21 Hematology analyzer (Sysmex Cooperation, Kobe, Japan). Anemia was defined as a hemoglobin concentration < 12 g/dl for females and <13.0 g/dl for males (16).

**Statistical Analysis**

The parametric data were analyzed with student t-test and ANOVA while the non-parametric data were analyzed with Chi square (X²) test and odd ratio analysis using the statistical software INSTAT® (GraphPad software Inc., La Jolla, CA, USA). Statistical significance was set at P<0.05.

**Results**

A total of 64 (25.9%) out of the 247 prospective donors examined had malaria parasite in their blood. The prevalence of asymptomatic malaria among the prospective blood donors did not differ significantly in relation to type of donor (P = 0.174), gender (P = 0.733), age (P = 0.581) and blood groups [ABO (P =0.446) and rhesus blood group (P =0.806)] (Table 1).

| Characteristics          | N     | No Infected (%) | OR   | 95% CI            | P value |
|--------------------------|-------|-----------------|------|-------------------|---------|
| Type of Donor            |       |                 |      |                   |         |
| Commercial               | 218   | 60 (27.5)       | 2.373| 0.793, 7.107      | 0.174   |
| Voluntary                | 29    | 4 (13.8)        | 0.421| 0.141, 1.262      |         |
| Gender                   |       |                 |      |                   |         |
| Male                     | 236   | 62 (26.2)       | 1.603| 0.337, 7.629      | 0.733   |
| Female                   | 11    | 2 (18.2)        | 0.624| 0.131, 2.967      |         |
| Age (Years)              |       |                 |      |                   |         |
| 15-20                    | 68    | 12 (17.6)       |      |                   | 0.581   |
| 21-26                    | 109   | 39 (35.7)       |      |                   |         |
| 27-32                    | 36    | 7 (19.4)        |      |                   |         |
| 33-38                    | 19    | 4 (21.1)        |      |                   |         |
| ≥39                      | 15    | 2 (13.3)        |      |                   |         |
| ABO Blood Group          |       |                 |      |                   |         |
| O                        | 141   | 42 (29.8)       |      |                   | 0.446   |
| A                        | 55    | 11 (20.0)       |      |                   |         |
| B                        | 43    | 9 (20.9)        |      |                   |         |
| AB                       | 8     | 2 (25.0)        |      |                   |         |
| Rhesus Blood Group       |       |                 |      |                   |         |
| -VE                      | 24    | 7 (29.2)        | 1.199| 0.473, 3.041      | 0.806   |
| +VE                      | 223   | 57 (25.6)       | 0.834| 0.329, 2.114      |         |

N- number tested; OR- odd ratio; CI- confidence interval
Age was observed to significantly affect malaria parasite density with donors within the age group of 21-26 years having the highest risk. Gender, type of donor, ABO and Rhesus blood groups did not significantly (P>0.05) affect malaria parasite density among study participants (Table 2). The prevalence of anemia was 21.1%. Type of donors was significantly associated with anemia with commercial donors having higher prevalence (commercial vs. voluntary: 23.4% vs. 3.4%; OR=8.551 95%CI =1.135, 64.437; P = 0.013). The prevalence of anemia was significantly (P< 0.0001) higher among blood group O donors compared with donors of other ABO blood groups. However, gender, age, rhesus blood group and presence of asymptomatic malaria did not significantly affect the prevalence of anemia (Table 3).

Table 2: Malaria parasite density among prospective blood donors

| Characteristics | No infected | Mean parasite density (±SD) | Pvalue |
|-----------------|-------------|----------------------------|--------|
| **Type of Donor** |             |                           |        |
| Commercial      | 60          | 225 (± 119.4)              | 0.057  |
| Voluntary       | 4           | 106 (± 42.7)               |        |
| **Gender**      |             |                           |        |
| Male            | 62          | 218.5 (±120.3)             | 0.162  |
| Female          | 2           | 112.5 (±24.7)              |        |
| **Age (Years)** |             |                           |        |
| 15-20           | 12          | 170.8 (±82.3)              | 0.015  |
| 21-26           | 38          | 246.3 (±137.0)             |        |
| 27-32           | 7           | 103.5 (±62.2)              |        |
| 33-38           | 4           | 168.8 (±66.4)              |        |
| ≥39             | 3           | 108.3 (±38.2)              |        |
| **ABO BloodGroup** |         |                           |        |
| O               | 42          | 196.4 (±172.5)             | 0.378  |
| A               | 11          | 125.0 (±46.3)              |        |
| B               | 9           | 133.3 (±57.4)              |        |
| AB              | 2           | 137.5 (±17.7)              |        |
| **Rhesus Blood Group** | |                           |        |
| +VE             | 57          | 213.1 (±100.13)            | 0.303  |
| -VE             | 7           | 189.28 (±80.17)            |        |

SD- standard deviation

Table 3: Prevalence of anemia among prospective blood donors

| Characteristics | N   | No Anemic (%) | OR   | 95% CI          | Pvalue |
|-----------------|-----|---------------|------|----------------|--------|
| **Type of Donor** |     |               |      |                |        |
| Commercial      | 218 | 51 (23.4)     | 8.551| 1.135, 64.437  | 0.013  |
| Voluntary       | 29  | 1 (3.4)       | 0.117| 0.016, 0.881   |        |
| **Gender**      |     |               |      |                |        |
| Male            | 236 | 50 (21.7)     | 1.210| 0.253, 5.780   | 1.000  |
| Female          | 11  | 2 (18.1)      | 2 (18.1)| 0.173, 3.950  |        |
| **Age (Years)** |     |               |      |                |        |
| 15-20           | 68  | 12 (17.6)     | 1.017|                |        |
| 21-26           | 109 | 31 (28.4)     |      |                |        |
| 27-32           | 36  | 6 (16.7)      |      |                |        |
| 33-38           | 19  | 2 (10.5)      |      |                |        |
| ≥39             | 15  | 1 (6.7)       |      |                |        |
| **ABO Blood Group** |   |               |      |                |        |
| O               | 141 | 45 (31.9)     | < 0.0001|            |        |
| A               | 55  | 4 (7.2)       |      |                |        |
| B               | 43  | 3 (6.9)       |      |                |        |
| AB              | 8   | 0 (0.0)       |      |                |        |
| **Rhesus Blood Group** | |               |      |                |        |
| -VE             | 24  | 9 (37.5)      | 2.512| 1.030, 6.125   | 0.061  |
| +VE             | 223 | 43 (19.3)     | 0.398| 0.163, 0.971   |        |
| **Malaria Status** | |               |      |                |        |
| Positive        | 64  | 19 (29.6)     | 1.919| 0.996, 3.697   | 0.074  |
| Negative        | 183 | 33 (18.0)     | 0.521| 0.271, 1.004   |        |

N- number tested; OR- odd ratio; CI- confidence interval

Available at: [http://ijpa.tums.ac.ir](http://ijpa.tums.ac.ir)
Discussion

This study aimed at determining the prevalence and associated risk factors for asymptomatic malaria infection and anemia among blood donors in Benin City, Nigeria. Malaria induced by blood transfusion is a potential health hazard. Sadly however, this is often neglected in many malaria endemic areas of the world (17).

The prevalence of asymptomatic malaria infection in this study was 25.9%. This is lower than values obtained in a number of Nigerian studies (17-21). The variation could be due to differences in geographical location as Uneka et al.,(17), Ekwunife et al.,(18), Okocha et al.,(19), Mbanugo et al.,(20), and Ali et al.,(21) were all conducted in eastern Nigeria in contrast to our study which was done in the mid-western region of the country. Asymptomatic malaria remains a challenge for malaria control programs as it significantly influences transmission dynamics (22). It often goes undetected and untreated, resulting in a major source of gametocytes for local mosquito vectors (23). In a malaria endemic country like Nigeria (24), where the screening of blood prior to transfusions is unpopular (25), and purchase and use of over the counter anti-malaria drugs is rife (26), blood donors may harbor plasmodia species asymptotically that have over time developed resistant genes to available anti-malaria drugs, further compromising the recovery of blood recipients.

The WHO recommends the recruitment of volunteer non-remunerated blood donors from low-risk populations to ensure the safety of transfused blood (27). Several studies have reported that infectious diseases are more prevalent among donors who are recruited by monetary incentives (28-30) as they may intentionally fail to identify high risk behaviors during the donation interview in order to obtain the incentive offered (31). In this study, commercial blood donors were observed to have a higher prevalence of asymptomatic malaria infection than voluntary blood donors, albeit the difference was not statistically significant. In areas where malaria is endemic, asymptomatic Plasmodium falciparum parasitaemia is common among immune inhabitants and a large proportion of individuals always harbor malaria parasites without any associated clinical symptoms (22). This may well account for this observation. Although male participants were observed to have a higher prevalence of asymptomatic malaria infection (26.2%), gender did not significantly affect its prevalence. Similar findings have been reported in other Nigerian studies (17, 32). Age, rhesus and ABO blood groups of blood donors were not risk factors for asymptomatic malaria infection among study participants. These findings have been reported elsewhere (32, 33).

Malaria parasite density was significantly affected by age of blood donors. Blood donors within the age group of 21-26 years were observed to have the highest parasite count. This is in line with a previous report (17). The WHO reports that young people in malaria endemic areas of sub-Saharan Africa are more disposed to malaria infection than older individuals (34). With respect to ABO blood group system, participants of the blood group O type were observed to have the highest burden (count) of malaria parasite, albeit the difference was not statistically significant. A previous study has reported that O blood group provides protection against malaria infection (35). It is however important to note that the study by Rowe et al., (35) was on patients with symptomatic malaria in contrast to ours which was on asymptomatic blood donors. This finding lends support to an earlier report elsewhere that ABO does not affect the parasite density but rather the clinical outcome of the disease where blood group O is known to protect against malaria (36).

The prevalence of anemia in this study was 21.1%, and is higher than 13.7% reported in another Nigeria study (37). An important factor to consider is that the etiology of anemia is multifactorial, and thus several underlying

Available at: http://ijpa.tums.ac.ir
morbid and co-morbid conditions could cause wide variations in the prevalence of anemia (38). Commercial donors were significantly more likely to be anemic. This is in line with an earlier Nigerian report (39). Commercial blood donors have been reported to donate blood much more frequently than volunteer donors (40). Repeated blood donation has been reported to be significantly associated with depleted iron store (41), which is known to contribute to the development of anemia. This may explain the observed higher prevalence of anemia among commercial donors in this study. The prevalence of anemia was significantly affected by ABO blood group with donors of the blood group O type having the highest prevalence. Blood group O individuals have been previously reported to have the highest prevalence of anemia in an Indian study (42). The reason for this finding however is not entirely clear. Many communities in Africa experience chronic shortage of blood for transfusion purpose (43). Perhaps, being able to serve a wider spectrum of blood recipients, blood group O donors may engage much more frequently in repeated blood donation than persons of other blood groups, within very short periods and thus run the risk of developing anemia.

**Conclusion**

Asymptomatic malaria parasitaemia and anaemia were observed to be higher among commercial blood donors than voluntary donors. Malaria parasite infected blood transfused to a non-immune individual is associated with fatal outcomes. Mandatory screening of blood donors for malaria parasite is advocated to curb transfusion transmitted malaria and associated squeal. Voluntary donation of blood should be encouraged.

**Acknowledgement**

Authors acknowledge with thanks all blood donors that participated in this study. The authors declare that there is no conflict of interests.

**References**

1. World Health Organization. World Malaria Report. Geneva: WHO Press; 2012. Available from: http://www.who.int/malaria/publications/world_malaria_report_2012/report/en/index.html.
2. George IO, Jeremiah I, Kasso T. Prevalence of Congenital Malaria in Port Harcourt, Nigeria. Br J Med Res. 2013; 3(2): 398-406.
3. Ogba O, Uneke CU. Hepatitis B virus and blood transfusion safety in sub-Saharan Africa. Int J Infect Dis. 2008; 7:2.
4. World Health Organization. Global database on blood safety: summary report. Geneva 2001: WHO Press; Available from: http://www.who.int/bloodsafety/GDBS_Report_2001-2002.pdf.
5. Tagny TC, Mbanya D, Tapko J, Lefre’rej. Blood safety in sub-Saharan Africa: a multifactorial problem. Transfus. 2008; 48(6):1256-61.
6. Awusi-ofori AK, Parry C, Bates I. Transfusion transmitted malaria in countries where malaria is endemic: A review of the literatures from sub – Saharan Africa. Clin Infect Dis.2010; 51(10):1192-8.
7. Kabiru EW, Kaviti JN. Risk of transfusion malaria in Nairobi. East Afr Med J. 1987; 64(12):825-7.
8. Saeed AA, Al Rasheed AM, Al Nasser I, Al Onaizi M, Al Kahtani S, Dubois L. Malaria screening of blood donors in Saudi Arabia. Ann Saudi Med. 2007; 22(5-6):329-32.
9. Tagny TC, Lobe MM, Mbanya D. Évaluation de deux méthodes de dosage de l’hémoglobine chez des donneurs de sang camerounais. Transfusion Clinique EtBiologique. 2006; 13: 331-4.
10. Rajab JA, Muchina WP, Orinda DA, Scott CS. Blood donor hematology parameters in two regions of Kenya. East Afr Med J. 2005;82: 123-7.
11. Adediran IA, Fesogun RB, Oyekunle AA. Haematological parameters in prospective Nigerian blood donors rejected on account of anemia and/or microfilaria infestation. Nigerian J Med. 2005; 14: 45–50.
12. Abodunrin OL, Bamidele JO, Olugbenga-Bello AI, Parakoy DB. Preferred choice of health facilities for health care among Adult Residents in Ilorin Metropolis, Kwara State, Nigeria. Int J Health Res. 2010; 3(2): 79-86.

13. World Health Organization. Blood donor selection: Guidelines on assessing donor suitability for blood donation, Geneva 2012; WHO Press: Available from: http://www.int/bloodsafety/publication/guide_selection_assessing_suitability.pdf.

14. Enosolease ME, Bazuaye GN. Distribution of ABO and Rh-D blood groups in the Benin area of Niger-Delta: Implication for regional blood transfusion. Asian J Transfus Sci. 2008; 2(1): 3-5.

15. Omoregie R, Adedokun RB, Ogefare HO, Iduh P, Duru M. Comparison of the efficiency of malaria PF rapid test device, Giemsa stained thick film and QBC in the diagnosis of malaria in Benin City, Nigeria. Mary Slessor J Med. 2007; 7:1-4.

16. World Health Organization. Blood Donor Selection: Guide line on assessing donor suitability for blood donation. Geneva: WHO Press: 2012. Available from: http://www.who.int/iris/handle/10665/76724.

17. Uneka CJ, Ogbo O, Nwoji V. Potential risk of induced malaria by blood transfusion in south eastern Nigeria. Mecgill J Med. 2006; 9(1): 8-13.

18. Ekwunife CA, Ozumba NA, Eneanya CI, Nwaorgu OC. Malaria infection among blood donors in Onitsha urban, Southeast Nigeria. Sierra Leone J Biomed Res. 2011; 3(1):21-6.

19. Okocha EC, Ibehe CC, Ele PU, Ibehe NC. The Prevalence of malaria in blood donors in Nigerian Teaching Hospital. J Vector Borne Dis. 2005; 42:21-4.

20. Mbanugo JI, Ememalo S. Prevalence of malaria parasitaemia among blood donors inOwerri, Imo State, Nigeria. Nigerian J Parasitol. 2004; 25: 75-80.

21. Ali J A, Okonko IO, Abraham AO, Kolade AF, Ogunjobi PN, Salako AO, Ojezele MO, Nwanze JC. A sero-survey of blood parasites (Plasmodium, Microfilaria, HIV, HBsAG, HCV antibodies) in prospective Nigerian blood donors. Res J Med Sci. 2010; 4 (4): 255-75.

22. Laishram DD, Sutton PL, Nanda N, Sharma VL, Sobit RC, Carlton JM, Joshi H. The complexities of malaria disease manifestations with a focus on asymptomatic malaria. Malaria J. 2012; 11:29.

23. Alves FP, Gil LH, Marrelli MT, Ribolla PE, Camargo EP, Da Silva LH. Asymptomatic carriers of Plasmodium sp. as infection source for malaria vector mosquitos in the Brazilian Amazon. J Med Entomol. 2005; 42:777-9.

24. Onyenekwe CC, Ukibe N, Mehudu SC, Ikenyi M, Ezeani M, Onochie A, Ofiaeli N, Abol N, Ilka A. Possible biochemical impact of malaria infection in subjects with HIV co-infection in Anambra state, Nigeria. J Vector Borne Dis. 2008; 45: 151–6.

25. Falade CO, Nash O, Akingbola TS, Michael OS, Olojede MO, Ademowo OG. Blood banking in a malaria-endemic area: evaluating the problem posed by malarial parasitaemias. Ann Trop Med Parasitol. 2009; 103:383-92.

26. Gbotosho GO, Happi CT, Ganiyu A, Ogundahunsi OA, Sowunmi A, Oduola AM. Potential contribution of prescription practices to the emergence and spread of chloroquinereistance in south-west Nigeria: caution in the use of artemisinin combination therapy. Malaria J. 2009; 8:313.

27. World Health Organization. Global Database on blood safety. Summary Report. Geneva: WHO press: 2011. Available from: http://www.who.int/bloodsafety/global_database/GDBS_Summary_Report_2011.pdf.

28. Eastlund T. Monetary blood donation incentives and the risk of transfusion-transmitted infection. Transfus. 1998; 38: 874–82.

29. Glynn SA, Smith JW, Schreiber GB, KleinmanSH, Nass CC, Bethel J, Biswan B, Thomson RA, Williams AE, Retrovirus Epidemiology donor study. Repeat whole-blood and plateletheresis donors: Unreported deferrable risks, reactive screening tests, and response to incentive programs. Transfus. 2001; 41:736–43.

30. Diro E, Alemu S, Johannes GA. Blood safety and prevalence of transfusion transmissible viral infections among donors at the Red Cross Blood bank Gondar University Hospital. Ethiop Med J. 2008; 46: 7-13.

31. Kasraian L, MaghsoodluM. Blood donors’ attitudes towards incentives: influence on motivation to donate. Blood Transfus. 2012; 10(2): 186–90.

Available at: http://ijpa.tums.ac.ir
32. Agboola TF, Ajayi MB, Adeleke MA, Gyang PV. Prevalence of malaria parasite among blood donors in Lagos University teaching hospital, Lagos Nigeria. Ann Biol Res. 2010; 1 (3):72-5.

33. Epidi TT, Nwani CD, Ugorji NP. Prevalence of malaria in blood donors in Abakaliki Metropolis, Nigeria. Sci Res Essay. 2008; 3 (4):162-4.

34. World Health Organization. African Malaria Report. Geneva: WHO Press: 2003. Available from: http://www.who.int/malaria/publications/atoz/whocdsma20031093/en/.

35. Rowe JA, Opi DH, Williams TN. Blood groups and malaria: fresh insights into pathogenesis and identification of targets for intervention. Curr Opin Hematol. 2009; 16(6): 480–7.

36. Vafa M, Troye-Blomberg M, Anchang J, Garcia A, Migot-Nabias F. Multiplicity of Plasmodium falciparum infection in asymptomatic children in Senegal: relation to transmission, age and erythrocyte variants. Malaria J. 2008; 7:17.

37. Jeremiah ZA, Koate BB. Anaemia, iron deficiency and iron deficiency anemia among blood donors in Port Harcourt, Nigeria. Blood Transfus. 2010; 8:113-7.

38. Oladeinde BH, Omorogbie R, Olley M, Anunibe JA, Onifade AA, Oladeinde OB. Malaria and anaemia among children in a low resource setting in Nigeria. Iran J Parasitol. 2012; 7(3):31-7.

39. Nwogoh B, Awodu OA, Bazuaye GN. Blood donation in Nigeria: Standard of the donated Blood. J Lab Physicians. 2012; 4: 94-7.

40. Buciuniene L, Stoniene L, Blazeviciene A, Kazlauskaite R, Skudiene V. Blood donors' motivation and attitude to non-remunerated blood donation in Lithuania. BMC Public Health. 2006; 6:166.

41. Abdullah SM. The effect of repeated blood donations on the iron status of male Saudi blood donors. Blood Transfus. 2011; 9(2): 167–71.

42. Pratima V, Shraddha S, Ashutosh K, Archna G, Ahilesh K. Prevalence of Anemia in adults with respect to Socio-Demographic status, Blood groups and religion in North Indian population. Int J Biol Med Res. 2012; 3(4): 2441-7.

43. Erhabor O, Adias TC. The challenges of meeting the blood transfusion requirements in Sub-Saharan Africa: the need for the development of alternatives to allogenic blood. J Blood Med. 2011;2: 7–21.