Original Article

The prevalence of malarial parasitaemia among blood donors in Ahmadu Bello University Teaching Hospital, Shika, Zaria, Nigeria

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ABSTRACT
BACKGROUND: Blood serves as a vehicle for transmission of blood-borne pathogens and transfusion-associated malaria is a major concern in malaria endemic countries. The study was conducted to determine the prevalence of malaria parasite among blood donors in Zaria, Nigeria.
METHODS: A total of 160 venous blood samples were screened for malaria parasites using Giemsa-stained thick and thin blood films between June and August 2011. The ABO phenotypes were classified using a haemaglutination standard test.
RESULTS: Of the 160 samples examined, 47 (29.4%) were infected. *Plasmodium falciparum* was the commonest species of *Plasmodium* detected in the study (80.5%: 38/47). The infection was significantly ($p<0.05$) detected more in female donors (43.8%: 7/16) than male donors (27.7%: 40/144) and was not associated with age. However the peak parasitaemia showed a bimodal distribution with donors in both age groups 26-35 and 36-45 having the highest prevalence (31%), while age group 18-25 had the lowest (25.7%: 9/35). Donors with blood group AB had the predominant infection rate (37.5%: 3/8) while blood group O had the least (26%: 25/94). Malaria parasite was detected with the highest prevalence at low (+) density (57.5%: 27/47).
CONCLUSION: The present study showed a considerable prevalence of asymptomatic malaria, hence some risk of malarial transmission by the blood donors. Therefore, careful screening for malaria parasite is recommended to ensure safe blood. Positive samples should be indicated on blood packs and curative antimalarial drugs followed by prophylactic drugs should be given to all recipients of parasitized blood. Commercial donors should be freely given mosquito treated bed nets and be encouraged to sleep under them.
KEYWORDS: Prevalence, Malaria, Blood Donors, Blood Group, Zaria, Nigeria.

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INTRODUCTION

Blood is life[1] and it is required for transporting oxygen and other essentials to tissues and carrying waste products from these tissues in the body. There is still no perfectly reliable man-made substitute for human blood[2]. Transfusion of blood and blood products saves lives and improves health and it involves transfer of biological material from man to man[1,3].

The demand for blood has greatly increased over the years with about 92 million blood donations collected worldwide each year[4]. Overall, 89% of the donations are screened following basic quality procedures implying more than 10 million units of blood are not screened for transfusion-transmissible infections (TTIs) [4]. These bloods are therefore unlikely to be totally free of the risk of TTIs. Widman[5] has asserted that, with every unit of blood, there is a 1% chance of transfusion associated problems including transfusion transmitted diseases. Therefore, providing safe and adequate blood should be an integral part of every country's national health care policy and infrastructure. But many patients requiring transfusion do not have timely access to safe blood[4] and blood safety is a major issue of global concern in transfusion medicine especially in developing countries, where national blood transfusion policies and services as well as financial resources are lacking or inadequate[1, 3]. Therefore, TTIs often threaten the safety of patients requiring blood transfusion, and medical care providers face serious challenges with blood availability, safety, and affordability[1].

The diseases transmitted by blood are HIV, hepatitis B and C, syphilis, malaria and infrequently cytomegalovirus, parvovirus, Epstein Barr virus and brucellosis[1]. Malaria is one of the world's deadliest diseases that are placing more than half of the world's population at risk[6]. It is caused by infection with single-celled parasites of the genus *Plasmodium* belonging to the Apicomplexan phylum[7]. In the vast majority of tropical and sub-tropical regions of the world, malaria remains the most complex and overwhelming health problem facing humanity, with 300 to 500 million cases and 2 to 3 million deaths per year[8]. About 90% of all malaria deaths in the world today occur in Africa south of the Sahara. The majority of infections in the region are caused by *Plasmodium falciparum*, the most dangerous of the five human malaria parasites[8].

Malaria still remains one of the most significant public health problems in Nigeria and perhaps the commonest cause of ill health in Africa. In Nigeria, malaria accounts for 25% of under-five mortality, 30% of childhood mortality and 11% of maternal mortality and it is responsible for 10% of Nigeria's hospital cases[7, 9]. All Nigerians are at risk of malaria and the problem is compounded by the increasing resistance of malaria to hitherto cost-effective antimalarial drugs[7].

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Transmission of malaria by blood transfusion is a significant problem in malaria endemic country like Nigeria. Several studies[6, 7, 9-14] conducted mostly in southern Nigeria have reported asymptomatic malarial parasitaemia among blood donors with prevalence ranging from 10.2% to 81.5%. Yet in Nigeria, screening for malaria parasite is neither routinely done in blood banks, nor stipulated in the current National Blood Transfusion Guidelines[12]. In Nigeria, as in other tropical developing countries, the high level of occurrence of blood-demanding health conditions due to increase in road traffic accidents, pregnancy-related haemorrhage, armed robbery attacks, and violent events, amplify the possibility of the transmission of blood-borne diseases[12]. There is little or no published information on malarial parasitaemia among blood donors in, Zaria, Kaduna State, located in northern Nigeria. This study was therefore conducted to determine the prevalence of malarial parasitaemia among blood donors, in Zaria, Nigeria. This is with the view of determining the possible risk of transmission of malaria parasites to recipients of donated bloods, and to providing scientific evidence required for the formulation of effective blood-donation policy in resource-constrained settings such as Nigeria.

MATERIALS AND METHODS

Study Area and Population

The study was conducted at the Ahmadu Bello University Teaching Hospital (ABUTH), Shika Zaria, Kaduna State, Nigeria between June and August 2011. Ahmadu Bello University Teaching Hospital is a referral hospital equipped with human and material resources to take care of the immediate health needs of patient from far and near and from other hospitals within and outside the state. Blood donors between ages 18 to 60 years old, irrespective of their sex, occupation and marital status were enrolled in the study.

Collection of Blood

About 2mls of blood sample were collected randomly (2 out of 5) from individuals within the study population and screened for HIV, HBV and HCV. Hence, the 160 blood samples collected were negative for HIV, HBC and HCV. The samples were collected by aseptic venipuncture into bottles containing anticoagulant Diethylenediamine tetra-acetic acid.

Blood Examination

Giemsa-stained thin and thick blood films were prepared according to the technique out lined by Cheesbrough[15] and described by Okonko *et al*.[7] The stained slides were examined microscopically for species identification. The parasite densities were determined by haematocrit method as outlined by Cheesbrough[15]. The collected blood samples were analysed within 1 to 2 hours of collection.

Packed Cell Volume Determination

The packed cell volume (PCV) is used to determine whether a blood donor is anaemic or not. Heparinized capillary tubes were used to collect blood sample amounting to one third of a capillary tube. The capillary tubes were sealed using Bunsen burner flame. The sealed capillary tubes were centrifuged at 2000 revolution per minute for 5minutes. The manual haematocrit reader was used to read the PCV. The haemoglobin concentration is one third of the PCV[15].

Blood Group Determination

The ABO blood grouping test was performed for all participants using the slide method as outlined previously[16] with commercially available reagents which produced strong agglutination within 1-2 minutes. Briefly: A drop of anti-A and antisera-B reagents were separately placed on a labeled slide. A drop of 20% test red cell suspension was added to each drop of the typing antiserum (the suspension may be prepared by adding 20 parts of red cells to 80 part of normal saline). The cells and reagent were mixed evenly over an area of 10-15mm diameter with a sterile stick. The slides were labeled and left for 2 minutes at room temperature and observed for agglutination.

Statistical Analysis

Data generated from the study were analysed using descriptive statistics. Differences in proportion were evaluated using the chi-square test. Statistical significance was achieved if $P < 0.05$.

RESULTS

Analysis of the results showed that, out of the 160 blood samples examined, malaria parasites were detected in 47, giving a prevalence of 29.4%. *Plasmodium falciparum* was identified in 80.9% (38/47) of the infected cases while *P. vivax* was identified in only one case (2.2%: 1/47) (Table 1).

Table 1: Prevalence of *Plasmodium species* in infected blood donors in ABUTH, Zaria, Nigeria

Plasmodium species	No. Infected (N = 47)	Percentage
P. falciparum	38	80.9
P. malariae	6	12.8
P. ovale	2	4.2
P. vivax	1	2.1

A male donor with PCV < 40 and a female donor with PCV < 37 were considered anaemic hence could not donate blood. Out of the 160 blood donors, 14 (8.75%) were anaemic, out of which 8 (57.1%) were males and 6 (42.9%) were females. Of the 47 malaria parasite infected donors, 7 (14.9%) were anaemic. Majority (71.4%: 5/7) of the malaria infected anaemic donors were females while 28.6% (2/7) were males (Figure 1).

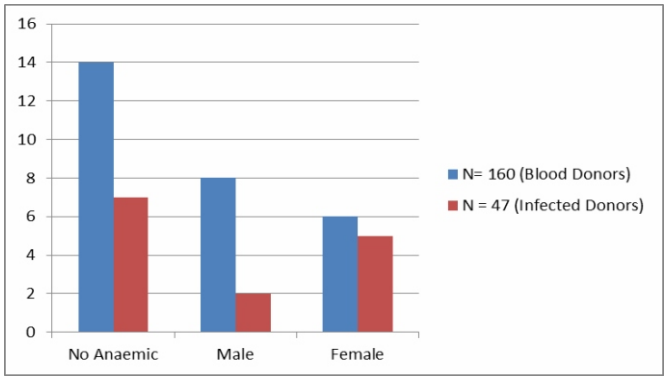

Figure 1: Anaemic status of malaria parasite infected blood donors by sex in ABUTH, Zaria

Analysis of the results based on gender showed that even though, majority of the blood donors were males (90%: 144/160), the infection was significantly ($p<0.05$) detected with higher frequency in female donors (43.8%: 7/16) than male donors (27.7%: 40/144) (Table2).

Table 2: Prevalence of malaria parasite in relation to Gender of blood donors in ABUTH, Zaria, Nigeria

Gender	Total	No. Infected	Percentage
Male	144	40	27.8
Female	16	7	43.7
Total	160	47	29.4

Malarial parasitaemia was not associated with age ($p>0.05$). However the peak parasitaemia showed a bimodal distribution, with donors in both age groups 26-35 and 36-45 having the highest prevalence of 31%, while donors in age group 18-25 had the lowest prevalence (25.7%: 9/35) (Table 3).

Table 3: Prevalence of malaria parasitaemia by age group of blood donors in ABUTH, Zaria, Nigeria

Age Group	Total	No. Infected	Percentage
18-25	35	9	25.7
26-35	58	18	31.0
36-45	35	10	28.6
46-60	32	10	31.2

The study population had all the blood group types with blood group O predominating. Blood group AB had the predominant infection rate (37.5%: 3/8) while blood group O had the least infection rate (26%: 25/94) (Table 4).

Table 4: Prevalence of malaria parasite by blood group of donors in ABUTH, Zaria, Nigeria

Blood Group	Total	Frequency	Percentage
A	25	9	36.0
AB	8	3	37.5
B	33	11	33.3
O	94	25	26.6

The parasite density ranged from low (+) to medium (++) to high (+++) with prevalence rates of 57.5%, 40.4%, and 2.1% respectively (Figure 2).

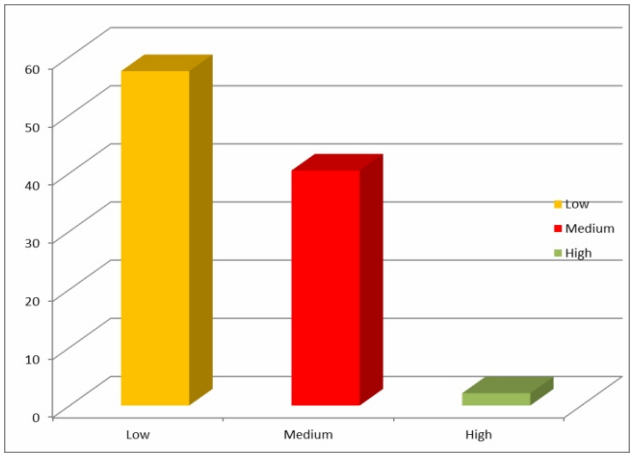

Figure 2: Percentage of malaria parasite density among blood donors in ABUTH, Zaria

DISCUSSION

This study shows that a substantial percentage of blood donors were infected with *Plasmodium* parasite which was worrisome. This is a reflection of the high rate of asymptomatic malarial parasitaemia in endemic malaria regions. The endemicity may be due to irrigated urban agriculture which can be the malaria vector's breeding ground in the city, stagnant gutters and swamps in our environment where mosquitoes breed in millions, lack of political will and commitment of the Government in its disease management program, low awareness of the magnitude of malaria problem, resistance of parasite to anti-malaria drugs, and inadequate health facilities. Others include lack of adequate accommodation and poor sanitary conditions especially in the area under study, poverty, and poor health practices by individuals. Poverty is a major problem in the study area, though the people may be aware of the endemic situation but lack the money to purchase quality drugs, treated nets and therefore purchases drugs with low efficacies from local drug hawkers at cheaper rate.

The prevalence obtained in the study is similar to that reported in southwestern and southeastern Nigeria where prevalence of 28%[9] and 30%[11] were respectively obtained among blood donors.

The prevalence is however higher than the 10.2% reported in the Niger delta of Nigeria[10] and lower that the 51% reported in Abakaliki, Ebonyi State, southeastern Nigeria[13], 46.5% reported in Ibadan[14], 81.5% reported in Abeokuta[7], and 74.1% reported in Onitsha, Southeastern Nigeria[6] among blood donors. We speculate that differences in geographical location and perhaps seasonal variation may have contributed to the differences observations in the prevalence.

Plasmodium falciparum was the predominated infectious species of *Plasmodium* detected in the study, conforming to previous reports from studies conducted in Nigeria. This finding may be as a result of agricultural practice and poor environmental sanitation of the study area which provide a suitable breading environment for the parasite vector. Majority of the malaria infected anaemic donors were females. This may be attributable to the monthly menstrual circle.

Despite the small number of female donors enrolled in the study, malaria parasitaemia predominated in female donors as previously reported[7, 9, 14]. However, the result contrasts a report from southeast Nigeria where male donors were reported to have the highest prevalence[11]. The small number of female donors may be due to low female enrolment for blood donation which is attributable to cultural and religious belief of the people in the study area. Meanwhile, there is yet to be documented relationship between malaria parasites and sex.

Malarial parasitaemia was not associated with age in this study. Some previous studies conducted in southern Nigeria have shown malarial parasitaemia among blood donors to significantly vary with age [6, 12, 14]. The lower parasitaemia observed in younger donors in the present study may be due to a higher level of immunity because of previous exposure while the higher parasitaemia in older donors may be due to depression of immunity as a result of stress. Although some studies have shown malaria parasitaemia to vary with age, however, there is yet to be a report that ascribes susceptibility of malaria parasite to any age group, except the immunocompromised, pregnant women and children[17].

Blood group AB had the predominant malaria infection rate in conformity with previous reports[11, 18]. The result however contrasts the report of Epidi *et al*.[13] and Chigozie *et al*.[19], where blood group A and O had the predominant malaria infection rates respectively. The result obtained in the present study can be explained as literature has it that an individual with blood group O has some level of resistance to *Plasmodium* parasite while those with blood group A are most susceptible to malaria parasite[20].

Malaria parasite was detected with the highest prevalence at low (+) density. This may be due to the endemicity of the infection, the season (rainy) of the year in which the study was carried out, and the resistance of parasite to anti-malaria drugs. In malaria endemic countries, transfusion transmitted malaria (TTM) can be a significant problem because of certain characteristics of malaria infection, i.e.: (a) Semi-immune individuals with low level of parasitemia remain asymptomatic and can qualify as blood donors, (b) *Plasmodia*, is able to survive in blood stored at 4°C, and (c) The sensitivity of currently used methods for malaria screening (Microscopic examination: ~ 50 parasites/iL; rapid diagnostic device (RDT): ~ 100 parasites/iL) is much lower than that required to detect level of parasitemia capable of causing TTM (~ 0.00004 parasites/uL or 1-10 parasites/unit of blood)[21].

The low (+) density of parasitaemia obtained indicates a high level of asymptomatic malarial parasitaemia in more than half of the blood donors in the area of study. Because of the above mentioned characteristics of malaria infection, this finding indicates that some of the blood in the blood bank may be infected and as blood is not screened for malaria parasite before transfusion, the blood recipient may be at risk of TTM. The moderate (++) and high (+++) density of parasitaemia detected in the blood donors indicate a high level of tolerance of malarial parasitaemia among the donors in Zaria.

CONCLUSION

The present study, although conducted with a small sample size, showed that, one in three asymptomatic blood donors were infected with malaria parasite during the study. Hence malaria is endemic in Zaria. Therefore, there is risk of malaria parasite being transmitted to recipients by blood transfusion especially if the blood is not screened before transfusion. It is therefore recommended that all blood pints be screened very carefully for malaria parasites and blood packs marked negative or positive as the case may be. In case a patient is transfused with a malaria positive blood, the patient can be given a curative regimen of antimalarials, especially when the patient falls into the malaria vulnerable group (children, pregnant women, immigrants from outside malarious regions). Since most commercial donors are from low income groups, they should be freely given long lasting insecticide treated bed nets and door and window blinds.

They should also be educated on the importance of the items and encouraged to sleep under the nets. Furthermore, considering the danger involved in immuno-compromised recipients there is urgent need for considering the inclusion of malaria screening in satisfying a blood safe for transfusion.

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