Research Journal of Medical Sciences 4 (4): 255-275, 2010
ISSN: 1815-9346
© Medwell Journals, 2010

A Serosurvey of Blood Parasites (Plasmodium, Microfilaria, HIV, HBsAG, HCV Antibodies) in Prospective Nigerian Blood Donors

[1]J.A. Alli, [2]I.O. Okonko, [3]O.A. Abraham, [1]A.F. Kolade, [1]P.N. Ogunjobi
[1]A.O. Salako, [4]M.O. Ojezele and [5]J.C. Nwanze
[1]Department of Medical Microbiology and Parasitology,
University College Hospital, Ibadan, Nigeria
[2]Department of Biochemistry and Microbiology, Lead City University, Ibadan, Nigeria
[3]Department of Haematology, University College Hospital, Ibadan, Nigeria
[4]Department of Nursing Science, Lead City University, Ibadan, Oyo State, Nigeria
[5]Department of Pharmacology, Therapeutics Igbinedion University Okada, Edo State, Nigeria

Abstract: This study aimed to determine the prevalence of blood parasites (*Plasmodium falciparum*, Microfilaria, HIV, HBsAg, HCV antibodies) in prospective Nigerian blood donors. About 200 blood donors at University College Hospital, Ibadan, Nigeria were recruited for this study. Samples of blood were collected, transported, stored and processed using standard laboratory procedures. Additional information was obtained using a proforma specially designed for this purpose. Both paid and volunteer blood donors were screened for HIV, HBsAg and HCV antibodies using the rapid test kits. The presence of microfilaria in blood and low haematocrit were also checked for. Prospective donors were initially sorted using a structured questionnaire on risk behaviour and were physically examined. Screenings were done before bleeding them. Thick and thin blood films were also Giemsa stained and observed for the presence of malaria parasites (*Plasmodium falciparum*) while wet preparation and Mayer's haemalum was used for detection of microfilaria. The results showed that most of the blood donors in this study were males 84.5%. The male:female ratio was 5:1. The age of donors ranged from 18-65 years (mean age = 34.7 years). A total of 93 (46.5%) blood donors were positive for *Plasmodium falciparum* and only 2 (1.0%) were positive for filaria (*Mansonella perstans*). Higher rate of malaria parasite infection was observed in female donors, 51.6% (n = 16) than in their male counterparts, 45.6% (n = 77) while filarial infection was also found to be higher among the females 1 (3.2%) than their male counterparts 1(0.6%). However, prevalence of malaria parasite was not gender-dependent ($p = 0.535$; df = 1). Malaria parasite was found in all age groups; prevalence of malaria and filarial parasite was lower in subject <45 years of age, 41.4 and 0.6%, respectively relative to those 45 years and above 68.4 and 2.6%, respectively. However, prevalence of malaria parasite was age-dependent ($p = 0.03$; df = 1). Progressive increase in prevalence of malaria was observed as the age increases, filarial rate also followed regular pattern. Statistical analysis also showed no significant association between the prevalence of microfilaria and malarial infection ($p>0.05$; df = 1). Statistically there was no significant difference in the distri bution of parasitic load by age ($p = 0.082$; df = 1) and by gender ($p = 0.071$; df = 1). However, none of the blood donors in this study were positive for HBsAg or antibodies to HIV and HCV. Majority of the donors were blood group type O (51.0%). All blood group types had malaria parasites, blood group AB had the predominant infection rate, 3 (60.0%) for malaria parasites followed by A and O groups having 27 (51.9%) and 46 (45.9%), respectively. The blood group B had the least infection rate of 17 (41.5%). Microfilaria parasitaemia was only recorded in blood groups AB and O having 1 (20.0%) and 1 (0.9%) infection rate, respectively. Statistically, there was no significant difference in the distri bution of infections by blood groups ($p = 0.687$) and no significant difference between parasitic load and blood groups ($p = 0.488$). Examining the distribution of the infections by blood groups showed that infection rate did not follow any regular pattern. Also, malaria infection was higher among farmers (83.3%) and artisans (48.1%), donors with non-formal education (83.3%), undisclosed marital status (61.5%) involuntary donors (54.5%) and repeat donors (48.7%) and those donating for family members (47.7%), donors with history of blood transfusion (60.0%), past infections (54.5%) and history of medication (50.0%),

Corresponding Author: I.O. Okonko, Department of Biochemistry and Microbiology, Lead City University, Ibadan, Nigeria

as well as among those without history of jaundice (100.0%), surgery (47.6) and tattoo/incision/tribal marks (47.2%). The study has revealed the presence of malaria parasites and microfilaria transmission among Nigerian blood donors and the infection rate can be considered as high. Malaria parasite infection rate is high among the blood donors while filarial infection is low however, none of the blood donors were positive for HBsAg or antibodies to HIV and HCV, thus emphasizes the importance of routine screening of blood donors for malaria to prevent malaria transmission through blood transfusion. The need for intensive health education to encourage voluntary donation and promote the interest of females in blood donation is emphasized.

Key words: Blood donors, microfilaria, HIV, HBsAg, HCV, malaria, *Mansonella perstans*, *Plasmodium falciparum*, Nigeria

INTRODUCTION

Blood donation occurs when a healthy person voluntarily has his/her blood drawn. And such a person is referred to as a blood donor. The donated blood is used for transfusion or made into medication by a process called fractionation. Types of donors include voluntary donors, commercial donors, relative donors, family credit donors, fringe benefit donors, compelled donors. A donor comes to the blood bank he or she is examined for basic eligibility qualities such as skin rashes, the body weight of the donor is ascertained which should not be <50 kg, the body temperature, the pulse rate and blood pressure; systolic and diastolic pressure are checked for and all these must be within the normal range. Also, the age of the donor which should be between 18-60 years and the life style of the donor are asked for (Cheesbrough, 1992). Other screening test for donors includes the quality of the donors haemoglobin, a quantitative test to determine the Packed Cell Volume (PCV) of the red blood cells, syphilis, Human Immunodeficiency Virus (HIV), Hepatitis B surface Antigen (HBsAg) and Hepatitis C Virus (HCV) antibodies (Cheesbrough, 1992).

Large pools of blood donors are difficult to get in most donor centres in Nigeria donors come in trickles and only when there is pressing need. Predonation screening for transmissible agents using individualized rapid screening techniques is often employed to avoid wastage of blood bags and reagents (Salawu and Murainah, 2006). Worldwide, prospective blood donors are screened for blood transfusion-transmissible diseases (Adediran *et al*., 2005). Transfusion of blood and blood product is a life saving measure and benefits numerous patients worldwide. However, Transfusion-Transmitted Infections (TTIs) are the most commonly encountered complications in transfusion practice. Transfusion-transmissible infectious agents such as HBV, HIV, HCV and syphilis are among the greatest threats to blood safety for transfusion recipients and pose a serious public health problem (Buseri *et al*., 2009). Serological markers for hepatitis HBV, HCV and HIV are screened in blood banks routinely.

These tests are obligatory for transfusion safety and may give an idea about the seropositivity rates of a specific region (Afsar *et al*., 2010). The evaluation of the data of the prevalence of the TTIs, malaria parasites, microfilaria, HBV, HCV and HIV among blood donors permits an assessment of the acquisition of the infections in the blood donor population and consequently the safety of the collected donations. It also gives an idea for the epidemiology of these infections in the community (Bhattacharya *et al*., 2007; Afsar *et al*., 2010).

HIV, HBV and HCV are blood borne pathogens that can be transmitted through blood transfusion and could pose a huge problem in areas where mechanisms of ensuring blood safety are suspect (Umolu *et al*., 2005). Acquired immune deficiency syndrome is a life threatening complication of HIV which is a retrovirus having two strains namely HIV 1 and 2 (Muula, 2000). Sub Saharan Africa has been severely hit by the HIV/AIDS pandemics (Muula, 2000). HIV is now the leading cause of death in Africa replacing malaria and other communicable diseases. HBV and HIV are know to be transmitted through sexual intercourse, blood and blood products, shared needle, other body fluids such as semen, virginal fluid and breast milk (Umolu *et al*., 2005). The viral hepatitides HBV and HCV infections are known to occur in the general population and due to their mode of transmission through blood and blood products, it has made the provision of safe blood difficult and the screening of blood absolutely necessary (Olokoba *et al*., 2009). Individuals with chronic infection of viral hepatitides have a high risk of liver cirrhosis and hepatocellular carcinoma (Bhattacharya *et al*., 2007). HBV and HCV have similar routes of transmission namely through blood and blood products intravenous drug abuse, unsafe injections and sexual activity (Olokoba *et al*., 2009). Detection of hepatitis B surface antigen (HBsAg) in blood is diagnostic for infection with HBV and in the blood banks screening for HBsAg is carried out routinely to detect HBV infection (Bhattacharya *et al*., 2007). Similarly, anti-bodies to HCV (anti-HCV) are used to detect HCV infection

(Olokoba *et al*., 2009). HCV has been shown to have a worldwide distribution occurring among persons of all ages, genders, races and regions of the world (WHO, 1996). Various prevalence rates of anti-HCV antibodies have been documented in African countries. Prevalence rates reported from some African countries also differ from place to place. Karuru *et al*. (2005) reported 4.4% in Kenya in 2004, Lassey *et al*. (2004) recorded 2.5% in Ghana and 3.3% in Burkina Faso (Simpore *et al*., 2005). Nigeria, the nation as one of the countries highly endemic for viral hepatitis, the prevalence rate of HCV infection was earlier said to vary between 5.8 and 12.3% as reported by Inyama *et al*. (2005).

In tune with this, 5.8% prevalence was initially found among normal blood donors in Southern Nigeria (Udeze *et al*., 2009) different states in Nigeria such as Lagos, Osun and Plateau states have recorded anti-HCV antibody prevalence rates of 8.4% (Ayolabi *et al*., 2006), 9.2% (Ogunro *et al*., 2007) and 5.7% (Inyama *et al*., 2005) among blood donors, pregnant women and HIV patients, respectively. However, Imoru *et al*. (2003) reported HCV antibody prevalence of as low as 0.4% among male blood donors in Kano state. The sero-prevalence of 6.0% in blood donors was also reported by Egah *et al*. (2004) in Plateau state. With the low prevalence of anti-HCV in developed countries, the risk of infection is still estimated at about 1:100,000. This risk is expected to be higher in the environment where the prevalence is high in addition to the virtual non-existence of testing methods for HCV markers (Egah *et al*., 2004).

HBV infection with its associated sequelae is a disease of major public health importance worldwide. Globally it is estimated that about 320-350 million individuals are chronic carriers of HBV and about 1.5 million people die annually from HBV-related causes (Alao *et al*., 2009). HBV infection occurs frequently in Nigeria (Alao *et al*., 2009). In fact it is estimated that about 12% of the total Nigerian population are chronic carriers of HBsAg (Alao *et al*., 2009).

Studies from different parts of Nigeria have reported varying prevalence rates among selected groups (Ejele and Ojule, 2004; Alao *et al*., 2009). Most people infected by these viruses have no symptoms and do not know that they carry the virus but all who are infected can transmit the virus to others (Nelson *et al*., 2000). This is further compounded in cases of donors in that after testing positive to the viruses, counselling is withheld as it is thought that it may frustrate donors and lower the blood pool. The effect of this action is that those uncounselled seropositive donors are innocently infecting the society (Umolu *et al*., 2005). Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes. It still remains one of the unconquered diseases in the world today. It is common in the tropics, especially in the south of Sahara (WHO, 2010). Malaria is the most important tropical parasitic disease affecting about 247 million people each year among the 3.3 billion people at risk resulting in nearly a million deaths, mostly children under the age of 5 years (WHO, 2008; Abdullahi *et al*., 2009). Nearly 90% of these deaths occur in Africa south of the Sahara thereby making it the leading cause of under-five mortality, killing an African child every 30 sec (WHO, 2005a; Abdullahi *et al*., 2009). Although, co-infection with HIV and malaria does cause increased mortality this is less of a problem than with HIV/tuberculosisco-infection due to the two diseases usually attacking different age-ranges with malaria being most common in the young and active tuberculosis most common in the old (Korenromp *et al*., 2005). Although HIV/malaria co-infection produces less severe symptoms than the interaction between HIV and TB, HIV and malaria do contribute to each other's spread. This effect comes from malaria increasingviral loadand HIV infection increasing a person's susceptibility to malaria infection (Abu-Raddad *et al*., 2006).

In 2008, malaria caused nearly 1 million deaths, mostly among African children. Malaria is preventable and curable. Malaria can decrease gross domestic product by as much as 1.3% in countries with high disease rates. Non-immune travelers from malaria-free areas are very vulnerable to the disease when they get infected (WHO, 2010). Malaria causes about 350-500 million infections in humans and it is responsible for approximately 1.3-3 million deaths annually (Snow *et al*., 2005). In 2008, there were 247 million cases of malaria and nearly 1 million deaths mostly among children living in Africa. In Africa a child dies every 45 sec of Malaria, the disease accounts for 20% of all childhood deaths (WHO, 2010). In Africa, mortality remains high because there is limited access to treatment (Weather *et al*., 2002). Children and pregnant women living in malaria endemic areas are at risk of varying degrees of malaria morbidity and mortality (Falade *et al*., 2007). Between 25 and 39% of deaths in children <5 years old has been attributed to malaria infection (Greenwood *et al*., 2005; Macete *et al*., 2006).

Approximately half of the world's population is at risk of malaria. Most malaria cases and deaths occur in sub-Saharan Africa. However, Asia, Latin America and to a lesser extent the Middle East and parts of Europe are also affected (WHO, 2010). In 2008, malaria was present in 108 countries and territories (WHO, 2010). Malaria remains a major cause of mortality among children under the age of 5 years it is endemic throughout Nigeria with seasonal

variation in different geographic zones of the country (Abdullahi *et al*., 2009). In Nigeria, malaria is endemic and stable being a major cause of morbidity and mortality, resulting in 25% infant and 30% childhood mortality (FMH, 2005a). Tragically, the health status of children under the age of five and women has remained a major barrier to Nigeria's development. It is estimated that about 100 children under 1 year and 203 children under 5 years out of 1000, respectively die annually (Abdullahi *et al*., 2009). In other words, one out of every five Nigerian children dies before his/her fifth birthday (RBM, 2005). Among pregnant women, malaria is responsible for >1 in 10 deaths and accounts for considerable proportion of low birth weight babies born to these mothers. These babies born with low birth weight 7102 are usually at higher risk of dying from infant and childhood illnesses (RBM, 2005).

Malaria is endemic throughout Nigeria with seasonal variation in different geographic zones of the country. About >90% of the total population is at risk of malaria and at least 50% of the population suffers from at least one episode of malaria each year. Beyond the impact on children and pregnant women, it affects the general population (RBM, 2005; FMH, 2005b). The disease is the commonest cause of outpatient attendance across all age groups with about 66% of clinic attendance due to malaria and thus constituting a great burden on the already depressed economy (Abdullahi *et al*., 2009).

Malaria is caused by Plasmodium parasites. The parasites are spread to people through the bites of infected Anopheles mosquitoes called malaria vectors which bite mainly between dusk and dawn. Malaria is transmitted exclusively through the bites of Anopheles mosquitoes (WHO, 2010). Malaria parasites can also be transmitted by blood transfusions, although this is rare (Marcucci *et al*., 2004). There are four types of human malaria; *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale*. *Plasmodium falciparum* and *Plasmodium vivax* are the most common. *Plasmodium falciparum* is the most deadly.

In recent years, some human cases of malaria have also occurred with *Plasmodium knowlesi* a monkey malaria that occurs in certain forested areas of South-East Asia. The intensity of transmission depends on factors related to the parasite, the vector, the human host and the environment (WHO, 2010). From the thick film, an experienced microscopist can detect parasite levels (orparasitemia) down to as low as 0.0000001% of red blood cells. Diagnosis of species can be difficult because the early trophozoites (ring form) of all four species look identical and it is never possible to diagnose species on the basis of a single ring form; species identification is always based on several trophozoites. With the pros and cons of both thick and thin smears taken into consideration, it is imperative to utilize both smears while attempting to make a definitive diagnosis (Warhurst and Williams, 1996). The geographic distri bution of malaria within large regions is complex and malaria-afflicted and malaria-free areas are often found close to each other (Greenwood and Mutabingwa, 2002). In drier areas, outbreaks of malaria can be predicted with reasonable accuracy by mapping rainfall (Grover-Kopec *et al*., 2005). Malaria is more common in rural areas than in cities; this is in contrast todengue feverwhere urban areas present the greater risk (Van Benthem *et al*., 2005). For example, the cities of Vietnam, Laos and Cambodia are essentially malaria-free but the disease is present in many rural regions (Trung *et al*., 2004). By contrast in Africa malaria is present in both rural and urban areas, though the risk is lower in the larger cities (Keiser *et al*., 2004). The global endemiclevels of malaria have not been mapped since the 1960s. However, the Wellcome Trust, UK has funded the Malaria Atlas Project (Hay and Snow, 2006) to rectify this providing a more contemporary and robust means with which to assess current and future malaria disease burden.

Human immunity is another important factor especially among adults in areas of moderate or intense transmission conditions (WHO, 2010). Immunity is developed over years of exposure and while it never gives complete protection it does reduce the risk that malaria infection will cause severe disease. For this reason, most malaria deaths in Africa occur in young children whereas in areas with less transmission and low immunity, all age groups are at risk. Transmission also depends on climatic conditions that may affect the abundance and survival of mosquitoes such as rainfall patterns, temperature and humidity. In many places, transmission is seasonal with the peak during and just after the rainy season (WHO, 2010). Malaria epidemics can occur when climate and other conditions suddenly favour transmission in areas where people have little or no immunity to malaria (WHO, 2010). They can also occur when people with low immunity move into areas with intense malaria transmission for instance to find work or as refugees.

Epidemiological patterns of malaria are widely different from one place to another (Himeiden *et al*., 2005). Specific data of a place collected can help in the making of a tailor-made design of improved programme for strategic malaria control for a particular location. There are available effective low-cost strategies for the treatment, prevention and control of malaria. But any attempt to prevent or control a disease such as malaria in any area or in a locality should first of all be preceded by an extensive

evaluation of the magnitude of the prevailing situation. Early diagnosis and treatment of malaria reduces disease and prevents deaths. It also contri butes to reducing malaria transmission (WHO, 2010). The best available treatment particularly for *P. falciparum* malaria is Artemisinin-based Combination Therapy (ACT). WHO recommends that malaria be confirmed by parasite-based diagnosis before giving treatment. Results of parasitological confirmation can be available in a few minutes. Treatment solely on the basis of symptoms should only be considered when a parasitological diagnosis is not possible (WHO, 2010).

In addition, predonation fitness requires adequate haematocrit and in the tropics, negative screening for microfilaria that may precipitate allergy (Adediran *et al*., 2005). The high prevalence of anaemia and microfilaria, though treatable has contri buted to the dearth of eligible blood donors (Adediran *et al*., 2005). Microfilariasis is a common infection frequently seen in most tropical and subtropical countries. It is the name of a group of tropical diseases caused by several species of nematode parasites and their larvae and it can be classified as an important blood infection.

The epidemiology of the disease in Nigeria is complicated because of the diversity of the environmental conditions of the different regions. Recently, large-scale dam and irrigation projects in addition to deteriorating drainage systems have created suitable breeding sites for filarial vectors in various parts of Nigeria (Anosike *et al*., 2003). Consequently, the disease distri bution is far more extensive than has been hitherto assumed (Anosike *et al*., 2003). In the past six decades, various levels of endemicity have been documented in different bioclimatic zones of Nigeria on filariasis.

These include those reported in the Galma river valley (Crosskey, 1981) in Eku, Delta state (Nmor and Egwunyenga, 2004) as well as in Ile-Ife, Osun state (Adediran *et al*., 2005; Salawu and Murainah, 2006) and in Garaha-Dutse community, Adamawa State Nigeria (Rebecca *et al*., 2008). Observations showed that one out of every three sufferers of onchocerciasis lives in the Federal Republic of Nigeria. Furthermore, several investigators have contri buted to establishing the existence of human filariasis due to *L. loa* and *W. bancrofti* infections in Nigeria (Ufomadu *et al*., 1991). Other studies on filariasis due to *M. perstans* and *M. streptocerca* infections have been vastly recorded in different parts of Nigeria.

Microfilariasis (such as Onchocerciasis) and Plasmodiasis are common human parastic infections in Africa with serious public health importance (Rebecca *et al*., 2008) while onchocerciasis causes high morbidity rate ranging from ocular, through dermatologic to systemic conditions (Egbert *et al*., 2000) among the affected population, malaria is known for its high mortality rate especially among the children under 5 years and pregnant women (Isibor *et al*., 2003). According to the World Health Organization out of the estimated 18 million people infected with *Onchocerca volvulus* globally over 80% live in Africa while 3.3 million of the global estimates reside in Nigeria (Rebecca *et al*., 2008). Human infection withmicrofilaria such as *Onchocerca volvulus* was investigated in 13 rural communities in the Upper Imo River basin, Imo State, Nigeria between March 1997 and December 2000 using the skin snip method by Dozie *et al*. (2004). Microfilariasis can be classified as an important blood infection.

Filariasis due to blood transfusion is a new topic in tropical medicine. However, changing population, demographics increased travel and immigration and the greater occurrence of certain asymptomatic infections in blood donors all led to the need for new policies to maintain transfusion safety in non-endemic areas. Clinical manifestation of the infections had been associated with the degree of body immunity and frequency of exposure to the insect vector (Rebecca *et al*., 2008). In Nigeria, onchocerciasis had been documented in almost all the states of the federation with exception of Lagos, Rivers and Akwa-Ibom State (Rebecca *et al*., 2008). The incidence of filarial parasites in donated blood is an interesting topic even though there are only a few reports on this subject.

On the contrary, transfusion associated infections with HIV, HBsAg, HCV, malaria parasites and microfilaria is a potentially serious complication that poses risks to blood recipients. Hence, there is need for effective screening of blood to improve on the exclusion policies of potentially infected carriers on the basis of their clinical history. In endemic countries like Nigeria excluding antibody-positive donation would result in too much wastage of blood units. However, antigen malaria testing appears to offer a potential utility as only few donations would be rejected (Awad *et al*., 2002). Cases of transfusion of imported malaria are increasing worldwide due to the frequency of traveling and increased demand for blood transfusion. Killer malaria due to *Plasmodium falciparum* can be acquired even with the transfusion of small number of infected red cells. A study on blood parasites in donors in a Nigerian Teaching Hospital by Okocha *et al*. (2005) revealed the following parasite prevalence: Malaria parasites for *Plasmodoim falciparum* (76.6%) and *P. malariae* (23.4%).

However, *Plasmodium falciparum* and microfilaria Asymptomatic Carriers (ACs), i.e., individuals harbouring parasites without clinical signs are numerous in areas of high transmission. The consequences and significance of

such asymptomatic infections have both been studied in diverse situations and from complementary approaches but these studies led to contradictory results (Henning *et al*., 2004). According to a few researchers, long term asymptomatic carriage may represent a form of tolerance to the parasite in children building up their immune response. In this way, asymptomatic carriage would protect these children from developing either a Mild Malaria Attack (MMA) or a more severe one by keeping their immunity effective. Conversely, asymptomatic carriage may represent a mode of entry to symptomatic malaria especially in young children (Henning *et al*., 2004).

It is important to understand the process which leads some of these children to suddenly develop a MMA. The time course of the relation between *Plasmodium falciparum* infection and MMA occurrence needed to be investigated. If the clinical outcome of infection can be determined by the host's ability to regulate the parasite growth over time, the way by which this regulation prevents the disease is incompletely known (Bruce and Day, 2003). Investigating this issue other important factors have to be considered such as the age of exposed children or the multiplicity of infections by different plasmodial populations in a single individual (Henning *et al*., 2004).

Treatment of asymptomatic individuals, regardless of their malaria infection status with regularly spaced therapeutic doses of antimalarial drugs has been proposed as a method to reduce malaria morbidity and mortality (O'Meara *et al*., 2006). This strategy called Intermittent Preventive Treatment (IPT) is currently employed for pregnant women (IPTp) and is being studied for infants (IPTi) and children (IPTc). The effects of repeated treatments on the development of immunity are the major challenges of intermittent preventive treatment (WHO, 2005a, b) and it is of great importance to increase the knowledge on the asymptomatic carriage of malaria parasites in order to help to assess the risk/benefit ratio of such new strategies.

It is important to establish whether or not the presence of malaria parasites in peripheral blood of asymptomatic individuals is a predictor of future clinical Mild Malaria Attacks (MMA) (Le Port *et al*., 2008). Malaria has been the subject of study in many parts of Nigeria (Nmor and Egwunyenga, 2004; Okafor and Oguonu, 2006; Akech *et al*., 2008; Rebecca *et al*., 2008; Falade *et al*., 2008; Ibekwe *et al*., 2009; Agomo *et al*., 2009). In this side of the globe however, there has been a paucity of published data on the concurrent infection between microfilaria and *Plasmodium* species in blood donors. Though, malaria prevalence studies had been undertaken in many parts of Nigeria, yet in malaria endemic countries like Nigeria, microfilaria and malaria parasite screening test is not included for donors. There is also probably no data available from the South Western region. Factors contributing to transfusion-related transmissions in sub-Saharan Africa include: high rates of transfusion in some groups of patients (particularly women and children); a high prevalence of Human Immunodeficiency Virus (HIV) in the general and blood donor populations inadequate screening facilities and lack of infrastructure and capacity to ensure sustainable operations (Holmberg, 2006). It should therefore, be mandatory that blood is screened for transfusion-transmissible infectious disease markers such as antibodies to HIV, HBV, HCV and HBsAg antigenaemia (Nwabuisi *et al*., 2005; Buseri *et al*., 2009), malaria and microfilaria inclusive. This study was undertaken to determine the prevalence of blood parasites (malaria, microfilaria, HIV, HBsAg, HCV) among asymptomatic Nigerian blood donors in order to generate baseline information.

MATERIALS AND METHODS

Study area: The study was carried out at the Blood Transfusion Unit of Department of Haematology, University College Hospital (UCH) Ibadan, Oyo State. UCH is located in the municipal area of Ibadan which is made up of five local government areas. Ibadan city lies 3°5'E and 7°23'N. The city is characterized by low level of environmental sanitation, poor housing and lack of potable water and improper management of wastes especially in the indigenous core areas characterized by high density and low income populations.

Study population: A total of 200 blood donors (169 males and 31 females) of different ages and socioeconomic status attending special treatment clinic at University College Hospital, Ibadan were enrolled in this study. The study was conducted from March-July, 2010 by recruiting consecutive consenting patients presenting at STC, UCH, Ibadan, Oyo State, Southwestern Nigeria until a total of 200 participants was attained. Prospective donors were initially sorted using a structured questionnaire on risk behaviour and were physically examined (Salawu and Murainah, 2006). Other relevant information of all participants was obtained using a proforma specially designed for this purpose. The study was approved by the ethical review committee of the hospital. The presence of microfilaria in blood and low haematocrit were also checked for. Screenings were done before bleeding them (Salawu and Murainah, 2006). Table 1 shows the characteristics of Nigerian donors used in this study.

Table 1: Demographical characteristics/parameters of Nigerian blood donors

Parameters	No. tested
Age group (years)	
<45	162 (81.0)
45 and above	038 (19.0)
Sex	
Male	169 (84.5)
Female	031 (15.5)
Marital status	
Single	71 (35.5)
Married	116 (58.0)
Undisclosed	13 (06.5)
Blood group	
A	52 (26.0)
B	41 (20.5)
AB	05 (02.5)
O	102 (51.0)
Occupation	
Traders	25 (12.5)
Farmers	06 (03.0)
Civil servants	17 (08.5)
Artisans	27 (13.5)
Undisclosed	125 (62.5)
Education	
Primary	26 (13.0)
Secondary	68 (34.0)
Tertiary	100 (50.0)
Non formal	06 (03.0)
Reasons for donation	
Voluntary donors	
Yes	88 (44.0)
No	112 (56.0)
Donating to save a life: family member/friend	
Yes	176 (88.0)
No	24 (12.0)
History of past donation	
Repeat donor	78 (39.0)
Fresh donor	122 (61.0)
History of blood transfusion	
Yes	05 (02.5)
No	195 (97.5)
History of jaundice	
Yes	01 (00.5)
No	199 (99.5)
History of surgery	
Yes	09 (04.5)
No	191 (95.5)
History of past infection (malaria, filariasis, rabies)	
Yes	11 (05.5)
No	189 (94.5)
Tattoo/incision/tribal marks	
Yes	23 (11.0)
No	178 (89.0)
History of previous medications	
Yes	54 (27.0)
No	146 (73.0)
Total	200 (100.0)

Specimen collection: The method of sample collection employed was venipuncture technique (Okocha *et al*., 2005). The samples of blood were collected into EDTA bottle. The specimens were transported in a commercially available collection and transport system for malaria parasites and microfilaria to medical microbiology and parasitology laboratory, UCH, Ibadan for analysis and processed using standard laboratory procedures.

Screening of blood donors for viral antigen/antibodies: Both paid and volunteer blood donors were screened for HIV, HBsAg and HCV antibodies using the rapid test kits. Routine screening for HBsAg was part of the criteria for donor selection. Any donor who tested negative would normally be bled while donors with positive results would normally not be bled but counselled. All tests were done using kits manufactured by Biotec laboratories, USA. The kit is based on latex agglutination methodology. The test kit contains latex particles coated with antibody to HBsAg, HIV and HCV. Serum containing the viral antigen will cause the latex particles to agglutinate. In the absence of viral antigens, the latex particles will remain homogeneous. Both positive and negative control sera were run along with the test samples using the same procedure.

Parasitological examination: Pheripheral blood samples were employed in this study. Two capillary tubes of blood were collected from the fingertip of each subject. Prior to the collection, the fingertips of the subjects were sterilized with cotton wool swabs soaked in methylated spirit and sterile disposable lancets were used through out for the collection. Thick films were made in duplicates from each blood sample on greesefree slides allowed to dry and stained by Geimsa technique as described by Cheesbrough (1992). Stained blood films were examined under x100 objective lens of a microscope with the aid of immersion oil for any stage of malaria parasites. Thick and thin blood films was prepared and stained with a 3% Giemsa solution for 45 min according to the technique outlined by Cheesbrough (1992) and observed according to the procedure of Hanscheid (1999); the number of asexual parasites per 200 White Blood Cells (WBCs) was counted and parasite densities were computed assuming a mean WBC count of 8,000/l. A slide was defined as negative if no asexual forms were found after counting 1,000 WBCs. Thin films were used for the species identification of Plasmodium parasites. Further confirmation of a positive sample was undertaken by an independent microscopist from the School of Medical Laboratory Sciences, University College Hospital, Ibadan, Nigeria to ensure quality control.

Wet preparation and Mayer's haemalum for microfilaria: This was carried according to the methods of Cheesbrough (1992). A drop of the anticoagulated blood was placed on a clean grease free slide and covered with a clean coverslip. Then examined under a microscope using 10 and ×40 objectives with condenser iris closed sufficiently to give a good contrast to observe for motile

microfilariae. A positive blood sample was smeared on a clean grease free slide to make thin and thick films which was stained with Mayer's Haemalum. The preparation was then examined for the presence of microfilarine under ×40 objectives lens of the microscope and recorded as positive or negative.

Determination of ABO blood group: Three spots of blood from each subject were made on the white plain tile and a drop of each antiserum A, B and D was applied to each spot, respectively. The mixture was further stirred with a plastic stirrer and rocked for some time. Signs of agglutination were observed showing red pigment. Antisera D were used to determine the Rhesus factor.

Data analysis: The data was subjected to statistical analysis (the-2-test with the level of significance set at $p<0.05$) using Statistical Package for Social Sciences (SPSS) to determine any significant relationship between infection rate, age and gender.

RESULTS AND DISCUSSION

A total of 200 blood samples from blood donors were collected between March, 2010 and July, 2010 of which 93 representing 46.5% were positive for *Plasmodium falciparum* parasites and 2 representing 1.0% were positive for microfilaria parasites. The study also aimed at determining the seroprevalence of viral hepatitides: HBV and HCV and HIV infection among voluntary blood donors. The literature also notes that these transfusion-transmissible viral infections can occur in blood donors (Ejele *et al*., 2005; Abdalla *et al*., 2005; Elfaki *et al*., 2008). Of the 200 blood donors screened, 93 (46.5%) tested positive for *Plasmodium falciparum* parasites, 2 (1.0%) for microfilaria parasites. None tested positive for HIV-1 and HIV-2, HBsAg and HCV infection (Table 2).

Table 2 shows the prevalence of asymptomatic blood parasitaemia in relation to the risk factors. The age specific infection rate showed that blood donors in 45 years and above years of age had the higher infection rate of 26 (68.4%) for malaria and 1 (2.6%) for filarial parasites than those in <45 years of age who had a total of 67 (41.4%) infection rate for malaria and 1 (0.6%) for filarial parasite (Table 2). Statistical analysis by chi-square however, showed significant difference in the distribution of infections with respect to age ($p = 0.003$). Examining the distri bution of the infections by age, progressive increase in prevalence of microfilariasis and malaria was observed as the age increases. There is significant association ($p = 0.003$) between the age groups of the blood donors and *Plasmodium falciparum* seropositivity (Table 2). The gender-specific infection rate showed that females had the higher infection rate of 16 (51.6%) for malaria and 1 (3.6%) for filarial parasites than their male counterparts who had a total of 77 infection (45.6%) for malaria and 1 (0.6%) for filarial parasites (Table 2). Statistically, there was no significant difference in the distribution of infections by gender ($p = 0.535$). Examining the distribution of the infections by gender, progressive increase in prevalence of microfilariasis and malaria was also observed as the rate of infection followed regular pattern. Thus there is no significant association ($p = 0.535$) between gender of the blood donors and *Plasmodium falciparum* seropositivity (Table 2).

The study according to blood groups showed that all blood group types had malaria parasites, though blood group AB had the predominant infection rate of 3 (60.0%) for malaria parasites followed by A and O groups having 27 (51.9%) and 46 (45.9%), respectively. The blood group B had the least infection rate of 17 (41.5%) as shown in Table 2. Microfilaria parasitaemia only recorded in blood groups AB and O having 1 (20.0%) and 1 (0.9%) infection rate, respectively (Table 2). Statistically, there was no significant difference in the distribution of infections by blood groups ($p = 0.687$). Examining the distribution of the infections by blood groups showed that infection rate did not follow any regular pattern. There is no significant association ($p = 0.687$) between blood group types of the blood donors and *Plasmodium falciparum* seropositivity, though this was not valid due to smaller sample size.

Also the study according to occupational groups showed that malaria infection was higher among farmers 83.3% (n = 5) followed by artisans 48.1% (n = 13), donors with undisclosed occupation status 48.0% (n = 60) and traders 44.0% (n = 11). Donors who belong to the civil servant occupational group had the least infection rate for malaria 23.5% (n = 4). Filarial infection was found only donors with farming as their occupational group 33.3% (n = 2) (Table 2). However, the difference in prevalence of infection by occupation is not statistically significant ($p>0.05$).

The study according to educational status showed that donors with non-formal education had the highest infection rate for malaria 83.3% (n = 5). This was followed by those with primary education 50.0% (n = 13), tertiary education 45.0% (n = 45) and those with secondary education had least infection rate of 44.1% (n = 30). In the same vein, filarial infection was found only in donors with secondary education having 6.7% (n = 2) infection rate as shown in Table 2. The study according to marital status showed that donors with undisclosed marital status 61.5% (n = 8) had the highest infection rate for malaria

Table 2: Risk factors for asymptomatic blood parasitaemia among Nigerian blood donors

Risk factors	No. tested (%)	No. positive for *Plasmodium falciparum* (%)	No. positive for microfilaria parasite (%)	No. positive for HIV, HbsAg, HCV (%)
Age group (years)				
<45	162 (81.0)	67 (41.4)	01 (00.6)	00 (00.0)
45 and above	038 (19.0)	26 (68.4)	01 (02.6)	00 (00.0)
Sex				
Males	169 (84.5)	77 (45.6)	01 (00.6)	00 (00.0)
Females	031 (15.5)	16 (51.6)	01 (03.2)	00 (00.0)
Marital status				
Single	71 (35.5)	25 (35.2)	01 (01.4)	00 (00.0)
Married	116 (58.0)	50 (43.1)	01 (00.9)	00 (00.0)
Undisclosed	13 (06.5)	08 (61.5)	00 (00.0)	00 (00.0)
Blood group				
A	52 (26.0)	27 (51.9)	00 (00.0)	00 (00.0)
B	41 (20.5)	17 (41.5)	00 (00.0)	00 (00.0)
AB	05 (02.5)	03 (60.0)	01 (20.0)	00 (00.0)
O	102 (51.0)	46 (45.9)	01 (00.9)	00 (00.0)
Occupation				
Traders	25 (12.5)	11 (44.0)	00 (00.0)	00 (00.0)
Farmers	06 (03.0)	05 (83.3)	02 (33.3)	00 (00.0)
Civil servants	17 (08.5)	04 (23.5)	00 (00.0)	00 (00.0)
Artisans	27 (13.5)	13 (48.1)	00 (00.0)	00 (00.0)
Undisclosed	125 (62.5)	60 (48.0)	00 (00.0)	00 (00.0)
Education				
Primary	26 (13.0)	13 (50.0)	00 (00.0)	00 (00.0)
Secondary	68 (34.0)	30 (44.1)	02 (06.7)	00 (00.0)
Tertiary	100 (50.0)	45 (45.0)	00 (00.0)	00 (00.0)
Non formal	06 (03.0)	05 (83.3)	00 (00.0)	00 (00.0)
Reason for donation				
Voluntary donation				
Yes	88 (44.0)	39 (44.3)	00 (00.0)	00 (00.0)
No	112 (56.0)	61 (54.5)	02 (01.8)	00 (00.0)
Donating to save a life (family members/friends)				
Yes	176 (88.0)	84 (47.7)	02 (01.1)	00 (00.0)
No	24 (12.0)	09 (37.5)	00 (00.0)	00 (00.0)
History of previous donation				
Repeat donor (donated before)	78 (39.0)	38 (48.7)	00 (00.0)	00 (00.0)
Fresh donor (donating for the first time)	122 (61.0)	55 (45.1)	02 (01.6)	00 (00.0)
History of blood transfusion				
Yes	05 (02.5)	03 (60.0)	00 (00.0)	00 (00.0)
No	195 (97.5)	90 (46.2)	02 (01.0)	00 (00.0)
History of jaundice				
Yes	01 (00.5)	00 (00.0)	00 (00.0)	00 (00.0)
No	199 (99.5)	93 (100.0)	02 (01.0)	00 (00.0)
History of surgery				
Yes	09 (04.5)	02 (22.2)	00 (00.0)	00 (00.0)
No	191 (95.5)	91 (47.6)	02 (01.0)	00 (00.0)
History of past infection (malaria, filariasis, rabies)				
Yes	11 (05.5)	06 (54.5)	00 (00.0)	00 (00.0)
No	189 (94.5)	87 (46.0)	02 (01.0)	00 (00.0)
Tattoo/incision/tribal marks				
Yes	23 (11.0)	09 (39.1)	00 (00.0)	00 (00.0)
No	178 (89.0)	84 (47.2)	02 (01.1)	00 (00.0)
History of medication				
Yes	54 (27.0)	27 (50.0)	00 (00.0)	00 (00.0)
No	146 (73.0)	66 (45.2)	02 (01.4)	00 (00.0)
Total	200 (100.0)	93 (46.5)	02 (01.0)	00 (00.0)

compared to their married and single counterparts having 43.1% (n = 50) and 35.2% (n = 25), respectively. Filarial infection was only found among donors with single 1 (1.4%) and married status 1 (0.9%) however, no filarial infection was found among donors with undisclosed marital status (Table 2). The study according to reason for donation showed that donors who donated involuntarily had higher infection rate for malaria 54.5% (n = 61) than voluntary donors 44.3% (n = 39). No voluntary donor had filarial infection (Table 2). Also, those donating to save a life of either family member or a friend had higher infection rate of 47.7% (n = 84) for malaria than those donating for other reasons 37.5% (n = 9) however, 2 (1.1%) of the family/friend donors had filarial infection (Table 2).

The study according to various histories of donors showed that donors with history of previous donation i.e., those who had donated before (repeat donors) had higher infection rate 48.7% (n = 38) than those donating for the first time (fresh donors) 45.1% (n = 55) however, 2 (1.6%) of the fresh donors had filarial infections. Donors with previous history of blood transfusion had higher infection rate of 60.0% (n = 3) for malaria than those without such history 46.2% (n = 90) and 2(1.0%) of the donors without history of blood transfusion had filarial infections (Table 2).

Donors with history of past infections had higher infection rate of 54.5% (n = 6) for malaria than those without past history of infection 46.0% (n = 87). Filarial infection was not found among donors with history of past infection it was found only among those without such history 2 (1.0%) as shown in Table 2. Donors with history of previous medication had higher infection rate of 50.0% (n = 27) than those without such history 45.2% (n = 66) and filarial infection was only found among donors without history of previous medication 2 (1.4%) as shown in Table 2.

Malaria infection was higher among those with no history of jaundice 93 (100.0%), no surgery 91 (47.6) and no tattoo/incision/tribal marks 84 (47.2%) as shown in Table 2. However, no filarial infection was found among repeat donors and donors with history of blood of transfusion, jaundice, surgery, past infection, previous medication and tattoo/incision/tribal marks (Table 2). However, the difference in prevalence of infection by clinical histories is not statistically significant ($p>0.05$).

Table 3 shows the *Plasmodium falciparum* parasitaemia load/density among Nigerian blood donors. The study according to parasite loads/density showed that the 69 (74.2%) blood donors who were positive for *Plasmodium falciparum* had parasitic load <250,000 μmL^{-1} while 24 (25.8%) of the blood donors who were also positive for *Plasmodium falciparum* had parasitic load of 250,000 μmL^{-1} and above (Table 3). Examining the distribution of *Plasmodium falciparum* load/density by various risk factors showed that parasitic load/density did not follow any regular pattern (Table 3).

The age-specific infection rate showed that blood donors in age group 45 years and above 10 (3.5%) had the higher Falciparum malaria parasitaemia load/density exceeding >250,000 parasites μL^{-1} of blood than those <45 years of age 14 (20.9%). In the same vein, majority of the donors 53 (79.1%) with Falciparum malaria parasitaemia value <250,000 parasites μL^{-1} of blood than their counterparts in age group 45 years and above 16 (61.5%). However, there is no significant association ($p = 0.082$) between the age groups of the blood donors and *Plasmodium falciparum* parasitaemia/load (Table 3). The gender-specific *Plasmodium falciparum* parasitaemia load/density showed that more females 7 (38.7%) had the higher Falciparum malaria parasitaemia/load exceeding >250,000 parasites μL^{-1} of blood than their male counterparts 17 (35.1%). Whereas majority of the male donors 50 (64.9%) had Falciparum malaria parasitaemia/load <250,000 parasites μL^{-1} of blood than their female counterparts 19 (61.3%). However, there is no significant association ($p = 0.071$) between gender of the blood donors and *Plasmodium falciparum* parasitaemia/load (Table 3).

The *Plasmodium falciparum* parasitaemia load/density exceeding 250,000 parasites μL^{-1} of blood according to blood group types showed that the parasite density was higher in individuals with blood group O [14 (30.4%)], B [4 (23.5%)] and A [6 (22.2%)] than those in the blood group AB [0 (0.0%)].

While the parasite density <250,000 parasites μL^{-1} of blood was higher in individuals with blood group AB [3 (100.0%)], A [21 (77.8%)] and B [13 (76.5%)] than those in the blood group O [32 (69.6%)]. However, there was no significant association ($p = 0.488$) between blood grouptypes of the blood donors and *Plasmodium falciparum* parasitaemia load/density though this was not valid due to smaller sample size.

In this study, two hundred blood donors were recruited and examined for presence of markers of transfusion transmission infections. From this study, the age range of blood donors was 18-65 years with a mean of 31.3 years.

This is similar to that in the study of Olokoba *et al.* (2009) who found that their blood donors in Yola, Adamawa State, Nigeria were in the age range of 18-61 years and Khan who found that their blood donors were in the age range of 18-60 years.

It is also similar to the findings of Muktar *et al.* (2005) in Zaria, Northwestern, Nigeria in which their donors had a mean age of 33 years even though their age ranged from 19-42 years. However, the donors in Jos, North-central, Nigeria were in the age range 21-50 years according to Egah *et al.* (2004). In this study, the male:female ratio was 5:1.

Most of the blood donors in this study were males, 84.5%. This is similar to the 95.0% in the study of Egah *et al.* (2004) and 96.0% in the study of Olokoba *et al.* (2009). Muktar *et al.* (2005) found that 98% of their donors were males while Nwokediuko in their study in Enugu, South-Eastern, Nigeria found that 91.8% of their donors were males. However, all the donors were males in the study of Elfaki *et al.* (2008) among the Sudanese and the study of Khan. Also, the study showed

Table 3: *Plasmodium falciparum* load/density among Nigerian blood donors

Risk factors	No. tested	No. positive for *Plasmodium falciparum* (%)	No. <250,000 (μ mL^{-1}) *Plasmodium falciparum* (%)	250,000 and above (μ mL^{-1}) *Plasmodium falciparum* (%)
Age group (years)				
<45	162 (81.0)	67 (41.4)	53 (79.1)	14 (20.9)
45 and above	038 (19.0)	26 (68.4)	16 (61.5)	10 (38.5)
Sex				
Males	169 (84.5)	77 (45.6)	50 (64.9)	17 (35.1)
Females	031 (15.5)	16 (51.6)	19 (61.3)	07 (38.7)
Marital status				
Single	71 (35.5)	25 (35.2)	17 (68.0)	08 (32.0)
Married	116 (58.0)	50 (43.1)	34 (68.0)	16 (32.0)
Undisclosed	13 (06.5)	08 (61.5)	08 (100.0)	00 (00.0)
Blood group				
A	52 (26.0)	27 (51.9)	21 (77.8)	06 (22.2)
B	41 (20.5)	17 (41.5)	13 (76.5)	04 (23.5)
AB	05 (02.5)	03 (60.0)	03 (100.0)	00 (00.0)
O	102 (51.0)	46 (45.9)	32 (69.6)	14 (30.4)
Occupation group				
Traders	25 (12.5)	11 (44.0)	06 (54.5)	05 (45.5)
Farmers	06 (03.0)	05 (83.3)	03 (60.0)	02 (40.0)
Civil servants	17 (08.5)	04 (23.5)	03 (75.0)	01 (25.0)
Artisans	27 (13.5)	13 (48.1)	10 (76.9)	03 (23.1)
Undisclosed	125 (62.5)	60 (48.0)	47 (78.3)	13 (21.7)
Education				
Primary	26 (13.0)	13 (50.0)	07 (53.8)	06 (46.2)
Secondary	68 (34.0)	30 (44.1)	22 (73.3)	08 (26.7)
Tertiary	100 (50.0)	45 (45.0)	39 (86.7)	06 (13.3)
Non formal	06 (03.0)	05 (83.3)	01 (20.0)	04 (80.0)
Reasons for donation				
Voluntary donors				
Yes	88 (44.0)	39 (44.3)	30 (76.9)	09 (23.1)
No	112 (56.0)	61 (54.5)	46 (75.4)	15 (24.6)
Donating to save a life-family member/friend				
Yes	176 (88.0)	84 (47.7)	62 (73.8)	22 (26.2)
No	24 (12.0)	09 (37.5)	07 (77.8)	02 (22.2)
History of past donation				
Repeat donor	78 (39.0)	38 (48.7)	28 (73.7)	09 (26.3)
Fresh donor	122 (61.0)	55 (45.1)	50 (90.9)	15 (09.1)
History of blood transfusion				
Yes	05 (02.5)	03 (60.0)	02 (66.7)	01 (33.3)
No	195 (97.5)	90 (46.2)	67 (74.4)	23 (25.6)
History of jaundice				
Yes	01 (00.5)	00 (00.0)	00 (00.0)	00 (00.0)
No	199 (99.5)	93 (100.0)	69 (74.2)	24 (25.8)
History of surgery				
Yes	09 (04.5)	02 (22.2)	02 (100.0)	00 (00.0)
No	191 (95.5)	91 (47.6)	67 (73.6)	24 (26.4)
History of past infection (malaria, filariasis, rabies)				
Yes	11 (05.5)	06 (54.5)	05 (83.3)	01 (16.7)
No	189 (94.5)	87 (46.0)	64 (35.9)	23 (64.1)
Tattoo/incision/tribal marks				
Yes	23 (11.0)	09 (39.1)	05 (55.6)	04 (44.4)
No	178 (89.0)	84 (47.2)	64 (76.2)	20 (23.8)
History of previous medication				
Yes	54 (27.0)	27 (50.0)	18 (66.7)	09 (33.3)
No	146 (73.0)	66 (45.2)	51 (77.3)	15 (22.7)
Total	200 (100.0)	93 (46.5)	69 (74.2)	24 (25.8)

that most donors were group O (51.0%). This is also similar to the findings of Umolu *et al.* (2005). The high frequency of those with blood group O in this study may also suggests that those with Blood group O may have a selective advantage over other blood groups. This also occurred in the study carried out by Lell *et al.* (1999) and Akanbi *et al.* (2010).

The results of this study have highlighted the fact that HIV, HBsAg and HCV infection is common in Ibadan, an urban area of Oyo state. Over the period under study, the seroprevalence rate of these viral infections among the blood donors was 0.0%. This is contrary to previous results reported among blood donors in different parts of Nigeria. Alao *et al.* (2009) reported the seropositivity rate of HBsAg among donors in Otukpo an urban area of Benue state to be 20%. Ejele and Ojule (2004) reported a prevalence rate of 1.57% among blood donors in Port Harcourt (1.57%). Muktar *et al.* (2005) reported 4.2%

HBsAg seropositivity rate among blood donors in Zaria, Northern Nigeria. Olokoba *et al.* (2009) reported a low seroprevalence of 2.4% for HBsAg among blood donors in Yola, Nigeria. This figure is lower than the 1.1% found by Ejele *et al.* (2005) in the Niger Delta region of Nigeria. It is also <1.2% found by Kagu *et al.* (2005) in North-Eastern, Nigeria, the 2.2% found by Bhatti *et al.* (2007) in Pakistani donors, the 4.0% reported by Abdalla *et al.* (2005) in Kenyan donors, the 8.3% by Muktar *et al.* (2005) in Tanzanian donors, the 10.0% found by Elfaki *et al.* (2008) in Sudanese blood donors; the 10.6% by Esumeh *et al.* (2003) in South-south, Nigeria the 5.4% reported by Umolu *et al.* (2005) among blood donors in Benin city, Nigeria; the 13.2% found by Fasola *et al.* (2009) in Ibadan, South-western, Nigeria; the 2.4% HBV infection rate among voluntary blood donors found by Olokoba *et al.* (2009) using HBsAg and more recently, the 14.5% overall HBsAg seroprevalence reported in Ibadan, the 15.0 and 13.8% among donors at University College Hospital (UCH) and Oyo State Blood Transfusion Centre (OSBTC), respectively by Lawal *et al.* (2009).

In relation to the HIV seroprevalence, the finding also differs from the 6.0% rate reported by Egah *et al.* (2004) among the 200 blood donors studied in Jos, Nigeria; the 4.55% in Cameroon (Musi *et al*., 2004). Umolu *et al.* (2005) also reported a 10.0% seroprevalence rate of HIV among blood donors in Benin city, Nigeria. Buseri *et al.* (2009) an overall seroprevalence of HBsAg, HIV, HCV and syphilis among prospective blood donors in Osogbo, Nigeria to be 18.6, 3.1, 6.0 and 1.1%, respectively. In their study (Buseri *et al*., 2009) the highest prevalences of HBsAg, HIV, HCV and syphilis infections occurred among commercial blood donors and those aged 18-47 years old, the most sexually active age group. The zero seroprevalence rate of HBsAg, HIV and HCV reported in this study differs from the 3.5% seroprevalence reported for HIV in Enugu (Chukwurah and Nneli, 2005) the 10.4% reported by Mustapha and Jibrin (2004) in Gombe, Nigeria; the 3.8, 8.8, 1.5 and 4.7% current seroprevalence of HIV, HBsAg, HCV and syphilis among blood donors at MNH in Dar es Salaam, respectively and the 8.7% for HBV, 1.6% for HCV and 4.6% for syphilis respective seroprevalences among HIV seronegative blood donors at MNH in Dar es Salaam, respectively reported by Matee *et al.* (2006). Chikwem *et al.* (1997) reported that the three most common infections transmissible through blood transfusion are HBV (14.9%), HIV-1 (5.8%) and *P. falciparum* (4.1%) among blood donors in Maiduguri, Nigeria. Oronsaye and Oronsaye (2004) reported 7.0% donors positive for HIV, 11.0% positive for HBsAg and 0.6% (n = 37) donors positive for both HIV and HBsAg among donors in UBTH, Benin city, Nigeria. From the study, no HCV infection was found among voluntary blood donors using anti-HCV antibodies. However, this is comparable to what was previously reported by Elfaki *et al.* (2008) who found no case of HCV infection in the 260 Sudanese blood donors they studied. This figure (0.0%) is <0.2% found in the research of Abdalla *et al.* (2005); the 0.5% in the research of Ejele *et al.* (2005) and the 1.5% found by Matee *et al.* (1999). The zero HCV infection rate in this study is also <3.0% found by Ezeani in Southeastern, Nigeria and the 3.7% found by Nwokediuko. Furthermore, the zero HCV infection rate is <3.9% found by Esumeh *et al.* (2003), the 4.2% in the researc of Bhatti *et al.* (2007); the 6.0% found in the research of Egah *et al.* (2004) and the 2.4% HCV infection rate found among voluntary blood donors Olokoba *et al.* (2009) using anti-HCV antibodies.

In relation to the HCV seroprevalence, the zero prevalence reported in the study differs greatly from the the 6% seroprevalence documented by Buseri *et al.* (2009); the 2.8% found among blood donors in Ghana; the 2.9% among blood donors in Port Harcourt (Koate *et al*., 2005); the 5.0% HCV was reported in Port Harcourt in the south of Nigeria (Jeremiah *et al*., 2008); the 8.0% HCV seroprevalence reported by Udeze *et al.* (2009) and more recently, the 13.5, 3.0 and 1.0% seroprevalences reported for HBsAg, HCV antibodies and co-infection of HBV/HCV, respectively (Opaleye *et al*., 2010).

The zero seroprevalence rate for HCV found in the study is however, relatively comparable to values ranging between 0 and 1.4% reported from USA and Europe (Sharara *et al*., 1996; Stevens *et al*., 1990) and the 0.12, 0.47, 0.64 and 0.48% seroprevalence of HIV, HBV (HBsAg), HCV and syphilis reported, respectively among blood donors in Kathmandu, Nepal (Shrestha *et al*., 2009). The results agreed favourably with Buseri *et al.* (2009) who also reported zero prevalence for HIV among voluntary. Chikwem *et al.* (1997) also reported no donors with HIV-2 or filarial infection. The wide differences in the HIV, HBV and HCV infection rate among the voluntary blood donors in the different regions within Nigeria and even outside Nigeria may be due to the differences in geographical locations, age range of donor patients, sample sizes, the period of time the studies were carried out and the different socio-cultural practices such as sexual behaviour, marriage practices, circumcision, scarification, tattooing etc. which take place in these regions (Olokoba *et al*., 2009). Access to healthcare, immunization practices and the laboratory test reagents used may also be contri butory factors (Olokoba *et al.* 2009).

The high rate of infection noticed in commercial donor may not be unconnected with lack of awareness, since most of the commercial blood donors in this part of the world are actually those from low socio-economic

class where the campaign against these dreaded diseases are limited. They still engage in indiscriminate unprotected sex and drug addiction which could even be a factor to which they decided to be commercial blood donors. They will need money to maintain their life style (sex and drugs). And it has earlier been reported that sex remains a major transmitter of both viruses in this part of the world (Umolu *et al*., 2005). Hence, extra care should be taken when it comes to blood from commercial donors. The apparent lack of incidence in these voluntary and commercial donors could be due to the fact that they are stable and probably aware of the HIV/hepatitis scourge (Umolu *et al*., 2005). This does not mean that voluntary donors are not carriers but the prevalence is low as some may also be involved in indiscriminate sex and drug addiction (Umolu *et al*., 2005). However, the involvement of those donating to save a life-family/friend (involuntary blood donor) is conclusive in this study, since the number of involuntary blood donors screened is statistically significant using the student t-test at 95% confidence limit (176 as against 88 for voluntary blood donors).

Although, blood transfusion is not thought as a significant mode of transmission, blood transfusion where mechanisms of ensuring blood surety are suspected, HIV and HBV is prevalent in the community and where many transfusions are conducted (sometimes needlessly), the problem can be high. There is also problem of the window period when the antigens or antibodies are not yet demonstrable; the blood can still transmit the infection (Alabi, 1999). The possibility of such transmission can be minimized by selecting donors at low risk of HIV and HBsAg infection and by screening blood for the presence of HIV antibodies and HBsAg. A single polymerase chain reaction assay that screen for HCV, HBV and HIV in a single assay is now available. African governments should try and make these kits available since it will aid in the diagnosis of these deadly viral infections since it has been noted that PCR can reduce the window period of HIV by 11 days. These viruses remain the greatest public heath problem as of today.

The total seroprevalence of microfilaria infection in the study population was 1.0% for a disease like filariasis due to *Mansonella perstans* that debilitates it can be described as low among these blood donors. The incidence of filarial parasites in donated blood is an interesting topic, even though there are only a few reports on this subject. According to Wiwanitkit a study on blood parasites among donors in Nigeria reviewed by Wiwanitkit revealed the following parasite prevalences: microfilaria of Loa loa (1.3%); Dipetalonema (*Mansonella*) *perstans* (15.6%); both Loa loa and *M. perstans* (0.2%), *Plasmodium falciparum* (3.3%), *P. malariae* (1.0%) and a mixture of *P. falciparum* and *P. malariae* (0.2%). According to another study by Akinboye and Ogunrinade, 11.3% of donors in Nigeria had blood parasites; 7.8% had *Plasmodium falciparum* with parasitaemias from 0.03-0.2 and 3.5% had Loa loa microfilaraemia. According to Choudhury *et al.* (2003), Microfilariae can be transmitted by blood transfusion and they may be circulated in the recipient's blood but they do not develop into adult worms. Mortality associated with transfusion associated filarial infection is not documented but it may give rise to morbidity in transfusion recipients in terms of allergic reaction (Choudhury *et al*., 2003).

Other studies on filariasis due to *M. perstans* and *M. streptocerca* infections have been vastly recorded in different parts of Nigeria and some parts of the world. Imported cases have also been described. Weller first reported on tourism-acquired *Mansonella ozzardi* microfilariaemia in a blood donor and this was the first warning of problematic transfusional filariasis in a non-endemic area. Transfusional *M. perstans* microfilariasis was reported from Milan by Bregani *et al.* (2003). In the experience of the reseacher in Thailand, no filarial parasites have been detected in the blood centre of a tertiary hospital for at least 10 years. However, there are sporadic cases in rural, endemic areas. At present, the recommendation to screen for filarial parasites in donated blood is limited only to some countries. There have been sporadic reported cases of transfusion filariasis. Choudhury *et al.* (2003) studied the association of post transfusion reactions and filarial infections in an endemic area of India and reported that filarial antibody was detected in 10.6% of blood donors but microfilariae were detected in 8.5%. Choudhury *et al.* (2003) concluded that transfusion associated filarial infection might be a probable cause of transfusion associated morbidity in endemic areas and allergic reactions due to this transfusion associated filarial infection were important. In their study (Choudhury *et al*., 2003), Microfilaria was concurrently present in 2 patients and their respective donors. Filarial antibody was detected in 27 (56.5%) patients and 26 (55.3%) blood donors but microfilaria was detected in 3 (6.4%) and 4 (8.5%) subjects, respectively. Dozie *et al.* (2004) reported a 26.8% seroprevalence rate of microfilariae in 13 rural communities in the Upper Imo River basin, Imo State, Nigeria. Budden (1963) reported the high incidence of microfilariae in the eye and of ocular lesions in relation to the age and sex of persons living in communities where onchocerciasis is endemic. Nmor and Egwunyenga (2004) reported an infection rate of microfilariae to be 8.2% among blood donors at Eku, Delta State, Nigeria. Adediran *et al.* (2005) also documented 16.7% infection rate for microfilaria alone and 8.3% for both anaemia and microfilaria among blood donors in

Ile-Ife, Osun state, Nigeria. Salawu and Murainah (2006) documented an infection rate of two (0.16%) blood donors with circulating microfilaria in Ile-Ife, Osun state, Nigeria. Rebecca *et al.* (2008) also reported an overall infection rate of 15.8% microfilariae and 8.4% concurrent infection with malaria in Garaha-Dutse community, Adamawa state Nigeria.

The present findings show that though microfilaria is a public health problem, it was low among the blood donors in the area of study. The results in this study also revealed a worrisome concomitant infection between filarial parasites and malaria infection. It is worthy of note that 2.2% of the total infected subjects had mixed infection, representing 1.0% of the entire sampled population. Statistically, no significant association exists between the prevalence of filarial parasites and the frequency of malaria infection ($p>0.05$). As for other blood infections, transfusion-related transmission is possible. Filariasis due to blood transfusion is a new topic in tropical medicine. However, changing population demographics increased travel and immigration and the greater occurrence of certain asymptomatic infections in blood donors all lead to the need for new policies to maintain transfusion safety in non-endemic areas. The lack of association in the distribution of both malaria and filarial infections in this study could also probably be traced to low prevalence, low infectivity rate and decreased vectoral capacity of the insect vectors which decreases their biting rates and decreased infection of the subjects. In a study earlier conducted, Egbert *et al.* (2000) reported a co-infection between microfilariasis and another disease condition.

In this study, filarial infection was found only in donors with farming as their occupational group. Similar finding was reported by Rebecca *et al.* (2008) who reported that of the total subjects examined for the parasites, farmers recorded the highest rate of Microfilaria (*Onchocerca volvulus*) infection 28.8% (19/66). Judging the prevalence of the infection from the occupational point of view, the prevalence rate of microfilaria (33.3%) and malaria (83.3%) parasite are higher among farmers and artisans than the other occupations in the study area. The finding is not surprising because according to Rebecca *et al.* (2008), the nature of daily activities of these groups of people often demands removal of some parts of their clothing for adequate airation after stressful work or to prevent the clothing from being soaked in water when fishing. All these behavioural activities exposed their body to the insect vectors (Rebecca *et al.*, 2008).

Also in this study, no filarial infection was found among repeat donors and donors with history of blood of transfusion, jaundice, surgery, past infection, previous medication and tattoo/incision/tribal marks. This is in consonance with earlier studies. Out of 47 patients showing post transfusion reaction in a study by Choudhury *et al.* (2003), 29 (61.7%) patients developed allergic reaction. About 18 (38.3%) patients having allergic reaction did not have previous history of blood transfusion and 14 (29.8%) of them received transfusion from blood donors who was either positive for microfilaria, filarial antigen or antibody (Choudhury *et al.*, 2003). In this study, filarial infection was not found among donors with history of past infection, it was found only among those without such history 2 (1.0%). Choudhury *et al.* (2003) reported filarial infection in 14 (29.8%) patients having allergic reactions claiming that the probable cause was transfusion-associated filarial infection. Transfusion associated filarial infection may be a probable cause for transfusion-associated morbidity in endemic areas (Choudhury *et al.*, 2003).

Although, some previous studies (Anosike and Abanobi, 1995; Anosike *et al.*, 2001, 2003) had reported a significantly higher filariasis among males than their female counterparts this study showed no significant difference in infection prevalence by gender ($p>0.05$). The reason for the present finding could probably be attributed to equal degree of exposure to *Simulium damnosum* and equal level of immunity of the blood donors. The results however agree with some previous findings (Ufomadu *et al.*, 1991; Usip *et al.*, 2006; Rebecca *et al.*, 2008). Age-related prevalence of filarial parasite infection did not increased progressively with age among the blood donors. This could be due to early acquisition of the infection at child hood which undergoes development with time. However, the present result is in consonance with earlier studies (Anosike and Onwuliri, 1995; Mas *et al.*, 1995).

Various studies have also established that malaria infection is accompanied by factors such as age, gender increased production of Reactive Oxygen Species (ROS), environment for oxidative stress (Akanbi *et al.*, 2009), plasma parameters (Farombi *et al.*, 2003) etc. and that children and pregnant women living in malaria endemic areas are at risk of varying degrees of malaria morbidity and mortality (Falade *et al.*, 2008). Unfortunately, most of these studies on prevalence of malaria infection have focused on children and pregnant women, neglecting adult males and non-pregnant females who are equally exposed to mosquito vectors (Akanbi *et al.*, 2010). This study showed that the total prevalence of malaria infection in the study population was 46.5% for a disease like malaria that debilitates it can be described as high. These results are >40% annual prevalence rate found in Nigeria (FMH, 2005a). This result is also higher than those

of Anumudu *et al.* (2006) who in a similar research in Eastern Nigeria reported 17% prevalence rate those of Nmor and Egwunyenga (2004) who reported an infection rate of 30.4% for Plasmodium among blood donors at Eku, Delta state, Nigeria. The finding is also higher than those of Rebecca *et al.* (2008) who also reported an overall infection rate of 28.0% plasmodiasis recorded as single infection and 8.4% concurrent infection with microfilariae in Garaha-Dutse community, Adamawa state Nigeria. However, the finding is comparable to those of Umeanaeto and Ekejindu (2006) who reported 46% prevalence in Nnewi, Anambra state. The overall prevalence of malaria reported in this study is even much lower than that of Aribodor who had reported 76% prevalence in Azia, Anambra state. The overall relative high prevalence could be due to presence of breeding sites for the Anopheles vector in some months of the year.

Plasmodium falciparuma symptomatic carriage concerns a very important proportion of exposed populations in endemic areas. However, the accurate definition of asymptomatic carriage relative to its duration (i.e., long term or short term) differs from one study to another (Le Port *et al.*, 2008). Conversely, the distribution of malaria infection in this study followed particular pattern with respect to age. This observation disagrees with some past findings (Nmor and Egwunyenga, 2004; Mbanugo and Emenalo, 2004; WHO, 2005b; Uneanaeto and Ekejindu, 2006; Abdullahi *et al.*, 2009). According to Abdullahi *et al.* (2009), children born to immune mothers are protected against the disease during their first half year of life by maternal antibodies. As they grow older, after continued exposure from multiple infections with malaria parasites over time, they build up an acquired immunity and become relatively protected against disease and blood stage parasites hence lower prevalence of malaria among the older age groups (Abdullahi *et al.*, 2009).

This is deviate completely from the findings of this study as the difference between infection rate in this study and the age group 45 years and above was statistically significant with $p = 0.003$.

In this study, the gender-specific infection rate of malaria showed higher infection rate in females (51.6%) than their male counterparts (45.6%). Statistically there was no significant difference in the distribution of infections by gender ($p = 0.535$). Examining the distri bution of the infections by gender, progressive increase in prevalence of malaria and as the rate of infection did not follow regular pattern. This observation disagrees with some past findings in other parts of Nigeria and the world. Past reports had indicated higher prevalence in males than females (WHO, 2005b, 2006). Abdullahi *et al.* (2009) also reported a statistically significant higher prevalence in males compared with their female counterparts but there is no scientific evidence to prove the higher prevalence being related to gender as susceptibility to malaria infection is not influenced by gender (Abdullahi *et al.*, 2009). The distribution of malaria infection in this study did not follow particular pattern with respect to gender. The result also shows no significant difference in the prevalence of parasite loads/density in relation to sex ($p = 0.071$). Conversely, the higher prevalence rate reported among females in this study could just be by chance or due to the fact that females now engage in activities like males which make them more prone to infective mosquito bites this further deviates and do not buttressed such claims made by WHS (2006).

The study according to blood groups also showed that all blood group types had malaria parasites, though blood group AB had the dominant prevalence. This disagrees with Nmor and Egwunyenga (2004) who reported dominant prevalence of blood parasites in blood group O. According to Akech *et al.* (2008), the major factors affecting haematological recovery were young age (<24 months) and concomitant malaria parasitaemia. Though no relationship exists between malaria, microfilaria, HBsAg, HCV and HIV with ABO blood group (UNICEF, UNAIDS, WHO, 1998; Umolu *et al.*, 2005). The study showed that most donors were group O (51.0%) and least were group AB (2.5%) and subsequently had the relatively high malaria and microfilaria seropositivity prevalence rates. Though, it is widely claimed that some individuals have the benefits of genetically controlled protection mechanisms against malaria such as blood group determinants, abnormal haemoglobin and red blood cell enzymes deficiency (Akanbi *et al.*, 2010). It has also been reported that severe malaria occurs more frequently in individuals with non-O blood group (Fischer and Boone, 1998; Akanbi *et al.*, 2010). However, there was no significant association found between blood group types and malaria seropositivity and parasite load/density ($p = 0.687$; $p = 0.488$).

The study according to *Plasmodium falciparum* load/density showed 69 (74.2%) seropositive blood donors had parasitic load <250,000 μ mL^{-1} while 24 (25.8%) seropositive blood donors had parasitic load of 250,000 μ mL^{-1} and above. Examining the distri bution of *Plasmodium falciparum* load/density by various risk factors showed that parasitic load/density did not follow any regular pattern. There is no significant association ($p = 0.082$, $p = 0.071$, $p = 0.488$) between the age groups, gender and blood group types of the donors, respectively and *Plasmodium falciparum* parasitaemia/load. High levels of parasitaemia resulting in

the activation of cytokines and the destruction of many red cells has been associated with the pathogenicity of *P. falciparum*. Falciparum malaria parasitaemia can exceed >250,000 parasites μL^{-1} of blood. Up to 30-40% of red cells may become parasitized (Cheesbrough, 1992). Though, malaria has been a major selective force on the human population resulting in emergence of several erythrocyte polymorphisms which confer resistance to severe malaria (Himiedan *et al*., 2004) this study finds no association between malaria parasite density and blood group types. Also, the parasite density exceeding 250,000 parasites μL^{-1} of blood was higher in individuals with blood group O, B and A than those in the blood group AB while the parasite density <250,000 parasites μL^{-1} of blood was higher in individuals with blood group AB, A and B than those in the blood group O with no significant association ($p = 0.488$). However, this study did not confirm the findings of Akanbi *et al*. (2010) who claimed that blood groups have an influence on malaria parasite density. This also disagrees with the previous studies where it has been reported that patients with blood group A have greater risk for severe malaria with a trend for a protective effect of blood group O (Fischer and Boone, 1998; Lell *et al*., 1999). The mechanism that are involved in rendering individuals with blood group A vulnerable to malaria may be related to the rosette formation by the *P. falciparum* with those with blood group A. It has been confirmed that some strains of *P. falciparum* preferentially trigger rosette formation depending on the red blood cell group (Barragan *et al*., 2000; Akanbi *et al*., 2010).

This study shows that age has a serious effect on the parasite density. It was also discovered that blood grouping and gender have no serious effect on the parasite density. In addition an individual living in malaria endemic areas also have the tendency to develop immunity against malaria infection (Akanbi *et al*., 2010). Thus in *Plasmodium falciparum* endemic areas, protective immunity against malaria infection is acquired slowly after a large number of infections and its maintenance requires a sustained exposure to infected mosquito (Akanbi *et al*., 2009). The level of immunity against malaria has also been related to age of the individuals living in malaria endemic areas (Akanbi *et al*., 2006, 2010). Different methods such as Intermittent Presumptive Treatment (IPT) and Insecticide-Treated bed Net (ITN) have been adopted to reduce the prevalence of malaria infection among pregnant women and children (Falade *et al*., 2007). This should be extended to other unselected population. The limitations of the study is that it was conducted using one tertiary health institution, though located in the strategic locations of the Ibadan city these results may reflect what is happening in other similar heath institutions in the metropolis. The results obtained are within limits compared to similar researches (Anumudu *et al*., 2006; Umeanaeto and Ekejindu, 2006) and also within the limits of the malaria prevalence rate reports in Nigeria (WHO, 2008; RBM, 2005; FMH, 2005b).

This base-line data could be useful in effective planning of tailor-made prevention and control measures among blood donors in the Ibadan and other similar cities.

CONCLUSION

The study has revealed the presence of malaria and filarial infection among asymptomatic Nigerian blood donors in Ibadan city of South Western Nigeria. The overall infection rate could be said to be high when compared to other studies. The importance of these findings has been discussed in line with the existing literature. In endemic areas, all donor blood should however be screened for malarial and filarial parasites. Filarial antigen detection test could prove to be more useful in detecting infections (Choudhury *et al*., 2003). Blood donors with active history of filarial infection should be deferred from donating blood. Filarial antigen detection test may be employed as screening test for blood donors, if possible (Choudhury *et al*., 2003).

This study also underscores the need for intensive health education to encourage voluntary donation and promote the interest of females in blood donation is emphasized. The finding of this study also confirms that blood transfusion will always represent a risk, through small to the recipient. Careful and critical examinations of blood donors to improve good donor selectionand transfusion practice are essential (Nmor and Egwunyenga, 2004). In line with the assertions of Buseri *et al*. (2009), it is important to point out that the findings of this study do not reflect the prevalence of markers of transfusion-transmissible infections in the unselected general population. This is because blood donors are a pre-selected group and majority of them are within the sexually active age group. Further studies aimed at determining the epidemiology of transfusion-transmissible infections among the general population will be of value in determining the population prevalence. Further studies could be undertaken to investigate other epidemiological parameters. On the side of the authority, the Government could reduce the infection rate further down by embarking on health education campaigns and training on malaria and filarial prevention particularly educating people on the importance of not providing conducive dwelling

places for mosquitoes (Abdullahi *et al*., 2009). The Government should also embark on extensive vector control to reduce the vector population and should subsidize anti-malarial drugs; children under the age of 5 years and adults 45 years and above of age should be given free malaria diagnosis and treatment. It should also provide and distri but e insecticide impregnated nets, free, at the Federal and State as well as at the Local Government levels.

ACKNOWLEDGEMENTS

We acknowledge those who participated in this study. The researchers express their sincere appreciation to the management of University College Hospital (UCH), Ibadan, Nigeria for granting an Associate of Medical Laboratory Science Council of Nigeria (AIMLSCON) programme and the assistance received from the Staff of Department of Medical Microbiology and Parasitology during this research. We would like to particularly thank the staff and management of School of the Medical Laboratory Science, UCH and the Department of Haematology, UCH, Ibadan for assisting us in the sample collection and Dr. WF Sule of the Department of Biological Sciences, Osun State University, Osogbo, Osun State, Nigeria for assisting us in data and statistical analysis. Miss MC Anigbo of School of the Medical Laboratory Science, UCH for assisting in samples collection. The effort of the medical laboratory scientist Mrs. PN Ogunjobi and Mr. II Olaosun is appreciated.

REFERENCES

Abdalla, F., O.W. Mwanda and F. Rana, 2005. Comparing walk-in and call-responsive donors in a national and a private hospital in Nairobi. East Afr. Med. J., 82: 531-535.

Abdullahi, K., U. Abubakar T. Adamu, A.I. Daneji and R.U. Aliyu *et al*., 2009. Malaria in Sokoto, North Western Nigeria. Afr. J. Biotechnol., 8: 7101-7105.

Abu-Raddad, L., P. Patnaik and J. Kublin, 2006. Dual infection with HIV and malaria fuels the spread of both diseases in sub-Saharan Africa. Science, 314: 1603-1606.

Adediran, I.A., R.B. Fesogun and A.A. Oyekunle, 2005. Haematological parameters in prospective Nigerian blood donors rejected on account of anaemia and/or microfilaria infestation. Nig. J. Med., 14: 45-50.

Afsar, I., S. Gungor, A.G. Sener and S.G. Yurtsever, 2010. The prevalence of HBV, HCV and HIV infections among blood donors in Izmir, Turkey. Indian J. Med. Microbiol., 26: 288-289.

Agomo, C.O., W.A. Oyibo, R.I. Anorlu and P.U. Agomo, 2009. Prevalence of malaria in pregnant women in Lagos, South-West Nigeria. Korean J. Parasitol., 47: 179-183.

Akanbi, O.M., A.B. Odaibo and O.G. Ademowo, 2006. Effect of age and anti- MSP1 (19) antibody (IgG) level on prevalence of malaria in pregnancy in southwestern Nigeria. Sci. Res. Ann., 2: 33-38.

Akanbi, O.M., A.B. Odaibo and O.G. Ademowo, 2009. Anti-MSP1 (19) antibody (IgG) and reactive oxygen species (ROS) response against malaria infection in pregnancy in South Western Nigeria. Asian Pacific J. Trop. Med., 2: 9-15.

Akanbi, O.M., J.A. Badaki, O.Y. Adeniran and O.O. Olotu, 2010. Effect of blood group and demographic characteristics on malaria infection, oxidative stress and haemoglobin levels in South Western Nigeria. Afr. J. Microbiol. Res., 4: 877-880.

Akech, S.O., O. Hassall, A. Pamba, R. Idro, T.N. Williams, C.R. Newton and K. Maitland, 2008. Survival and haematological recovery of children with severe malaria transfused in accordance to WHO guidelines in Kilifi, Kenya. Malaria J., 7: 256-256.

Alabi, G., 1999. Comments. Afr. Health, 22: 13-13.

Alao, O., E. Okwori, C. Egwu and F. Audu, 2009. Seroprevalence of hepatitis B surface antigen among prospective blood donors in an urban area of Benue State. Internet J. Hematol.

Anosike, J.C. and C.O. Abanobi, 1995. Resumption of men-struation in three women with secondary amenorrhea after treatment with livermectin. Ann. Trop. Med. Parasiotol., 89: 693-694.

Anosike, J.C. and C.O.E. Onwuliri, 1995. Studies on fiariasis in Bauchi State, Nigeria Endemicity of human onchocerciasis in Ningi local government area. Ann. Trop. Med. Parasitol., 89: 31-38.

Anosike, J.C., C.O.E. Onwuliri and V.A. Onwuliri, 2001. The Prevalence, intensity and clinical manifestations on *Onchocerca volvulus* infection in Toro local government of Bauchi State, Nigeria. Int. J. Hyg. Environ. Health, 203: 459-464.

Anosike, J.C., C.O.E. Onwuliri and V.A. Onwuliri, 2003. Human filariasis in Dass local government area of Bauchi state, Nigeria. Trop. Ecol., 44: 217-227.

Anumudu, C.I., A. Adepoju, M. Adeniran, O. Adeoye, A. Kassim, I. Oyewole and R.I. Nwuba, 2006. Malaria prevalence and treatment seeking behaviour of young Nigerian adults. Ann. Afr. Med., 5: 82-88.

Awad, A.S., A.M. Al Rasheed, I. Al Nasser, M. Al Onaizi, S. Al Kahtani and L. Dubois, 2002. Malaria screening of blood donors in Saudi Arabia. Ann. Saudi Med., 22: 329-332.

Ayolabi, C.I., M.A. Taiwo, S.A. Omilabu, A.O. Abebisi and O.M. Fatoba, 2006. Sero-prevalence of hepatitis C virus among blood donors in Lagos, Nigeria. Afr. J. Biotechnol., 5: 1944-1946.

Barragan, A., P.G. Kremsner, M. Wahlgren and J. Carlson, 2000. Blood group A antigen is a co-receptor in *Plasmodium falciparum* rosetting. Infect. Immune, 68: 2971-2975.

Bhattacharya, P., P.K. Chandra, S. Datta, A. Banerjee and S. Chakraborty *et al*., 2007. Significant increase in HBV, HCV, HIV and syphilis infections among blood donors in West Bengal, Eastern India 2004-2005: Exploratory screening reveals high frequency of occult HBV infection. World J. Gastroenterol., 13: 3730-3733.

Bhatti, F.A., Z. Ullah, N. Salamat, M. Ayub and E. Ghani, 2007. Anti-hepatitis B core antigen testing, viral markers and occult hepatitis B virus infection in Pakistani blood donors: Implications for transfusion practice. Transfusion, 47: 74-79.

Bregani, E.R., L. Balzarini, C. Ghiringhelli and P. Tarsia, 2003. Transfusional Mansonella perstans microfilariasis. Parassitologia, 45: 71-72.

Bruce, C.M. and K.P. Day, 2003. Cross-species regulation of *Plasmodium parasitemia* in semi-immune children from Papua New Guinea. Trends Parasitol., 19: 271-277.

Budden, F.H., 1963. The incidence of microfilariae in the eye and of ocular lesions in relation to the age and sex of persons living in communities where onchocerciasis is endemic. Trans. R. Soc. Trop. Med. Hyg., 57: 71-75.

Buseri, F.I., M.A. Muhibi and Z.A. Jeremiah, 2009. Sero-epidemiology of transfusion-transmissible infectious diseases among blood donors in Osogbo, South-West Nigeria. Blood Trans., 7: 293-299.

Cheesbrough, M., 1992. District Laboratory Practice in Tropical Countries. Part 1, Cambridge University Press, United Kingdom, pp: 239-258.

Chikwem, J.O., I. Mohammed, G.C. Okara, N.C. Ukwandu and T.O. Ola, 1997. Prevalence of transmissible blood infections among blood donors at the University of Maiducuri Teaching Hospital, Maiduguri, Nigeria. East Afr. Med. J., 74: 213-216.

Choudhury, N., P.K. Murthy, R.K. Chatterjee, M.A. Khan and A. Ayyagari, 2003. Transmission of filarial infection through blood transfusion. Indian J. Pathol. Microbiol., 46: 367-370.

Chukwurah, E.F. and R.O. Nneli, 2005. Prevalence of transfusion transmissible infectious disease markers among blood donors in a south Eastern state of Nigeria. Nig. Biomed. Sci. J., 1: 114-117.

Crosskey, R.W., 1981. A review of *Simulium damnosum* S.L. and human onchocerciasis in Nigeria with special reference to geographical distribution and the development of Nigerian national control campaign. Trop. Med. Parasitol., 32: 2-16.

Dozie, I.N.S., C.O.E. Onwuliri and B.E.B. Nwoke, 2004. Onchocerciasis in Imo state, Nigeria (2): The prevalence, intensity and distribution in the upper Imo river basin. Int. J. Environ. Health Res., 14: 359-369.

Egah, D.Z., B.M. Mandong, D. Iya, N.E. Gomwalk, E.S. Audu, E.B. Banwat and B.A. Onile, 2004. Hepatitis C virus antibodies among blood donors in Jos, Nigeria. Ann. Afr. Med., 3: 35-37.

Egbert, P.R., D.W. Jocobson, S. Fiadoyor, P. Dadzie and K.D. Ellingson, 2000. Onchocerciasis: A potential risk factor of glaucoma. Br. J. Ophthalmol., 89: 796-798.

Ejele, O.A. and A.C. Ojule, 2004. The prevalence of hepatitis B surface antigen (HBsAg) among prospective blood donors and patients in Port Harcourt, Nigeria. Nig. J. Med., 13: 336-338.

Ejele, O.A., O. Erhabor and C.A. Nwauche, 2005. The risk of transfusion-transmissible viral infections in the Niger-Delta area of Nigeria. Sahel Med. J., 8: 16-19.

Elfaki, A.M., A.A. Eldour and N.M. Elsheikh, 2008. Sero-prevalence of immunodeficiency virus, hepatitis B and C and syphilis among blood donors at ElObeid Teaching Hospital, West Sudan. Sudan J. Med. Sci., 3: 333-338.

Esumeh, F.I., D. Ugbomoiko and J.O. Isibor, 2003. Seroprevalence of HIV and Hepatitis B surface antigen (HBsAg) among blood donors in central hospital, Benin city, Nigeria. J. Med. Lab. Sci., 12: 52-55.

FMH, 2005a. Malaria Desk Situation Analysis Federal Ministry of Health. Publication of the FMH, FGN Publication,Publication of the FMH, FGN Publication, Nigeria, pp: 27.

FMH, 2005b. National Treatment Guidelines Federal Ministry of Health. Publication of the FMH, Nigeria, pp: 44.

Falade, C., O. Mokuolu, H. Okafor, A. Orogade and A. Falade *et al*., 2007. Epidemiology of congenital malaria in Nigeria: A multi-centre study. Trop. Med. Int. Health, 12: 1279-1287.

Falade, C.O., O. Olayemi, H.O. Dada-Adegbola, C.O. Aimaku, O.G. Ademowo and L.A. Salako, 2008. Prevalence of malaria at booking among antenatal clients in a secondary health care facility in Ibadan, Nigeria. Afr. J. Reprod. Health, 12: 141-152.

Farombi, E.O., Y.Y. Shyntum and G.O. Emerole, 2003. Influence of chloroquine treatment and plasmodium falciparum infection on some enzymatic and non-enzymatic ntioxidant defense indices in human. Drug Chem. Toxicol., 26: 59-71.

Fasola, F.A., T.R. Kotila and J.O. Akinyemi, 2009. Trends in transfusion-transmissible viral infections from 2001 to 2006 in Ibadan, Nigeria. Intervirol., 51: 427-431.

Fischer, P.R. and P. Boone, 1998. Severe malaria associated with blood group. Am. J. Trop. Med. Hyg., 58: 122-123.

Greenwood, B. and T. Mutabingwa, 2002. Malaria in 2002. Nature, 415: 670-672.

Greenwood, B.M., K. Bojang, C.J. Whitty and G.A. Targett, 2005. Malaria. The Lancet, 365: 1487-1498.

Grover-Kopec, E., M. Kawano, R. Klaver, B. Blumenthal, P. Ceccato and S.J. Connor, 2005. An online operational rainfall-monitoring resource for epidemic malaria early warning systems in Africa. Malaria J., 4: 6-6.

Hanscheid, T., 1999. Diagnosis of malaria: A review of alternatives to conventional microscopy. Clin. Lab. Haematol., 21: 235-245.

Hay, S.I. and R.W. Snow, 2006. The malaria atlas project: Developing global maps of malaria risk. PloS. Med., 3: e473-e473.

Henning, L., D. Schellenberg, T. Smith, D. Henning and P. Alonso *et al*., 2004. A prospective study of *Plasmodium falciparum* multiplicity of infection and morbidity in Tanzanian children. Trans. R. Soc. Trop. Med. Hyg., 98: 687-694.

Himeiden, Y.E., E.M. Malik and I. Adam, 2005. Epidemiological and seasonal pattern of malaria in irrigated areas of eastern Sudan. Am. J. Infect. Dis., 1: 75-78.

Himiedan, Y.E., M.I. Elbashir and I. Adam, 2004. Attractiveness of pregnant women to malaria vector-anopheles arabiensis, in Sudan. Ann. Trop. Med. Parasitol., 98: 631-633.

Holmberg, J., 2006. Activities Relating to Global Blood Safety at the Department of Health and Human Services. USA., pp: 1-5

Ibekwe, A.C., I.O. Okonko, A.I. Onunkwo, A.A. Ogun and A.O. Udeze, 2009. Comparative prevalence level of plasmodium in freshmen (first year students) of Nnamdi Azikwe University in Awka, South-Eastern, Nigeria. Malaysian J. Microbiol., 5: 51-54.

Imoru, M., C. Eke and A. Adegoke, 2003. Prevalence of Hepatitis-B Surface Antigen (HbsAg), Hepatitis C Virus (HCV) and Human Immunodeficiency Virus (HIV) among blood donors in Kano State, Nigeria. J. Med. Lab. Sci., 12: 59-63.

Inyama, P.U., C.J. Uneke, G.I. Anyanwu, O.M. Njoku, J.H. Idoko and J.A. Idoko, 2005. Prevalence of antibodies to Hepatitis C virus among Nigerian patients with HIV infection. Online J. Health Allied Sci., 2: 2-2.

Isibor, C.N., E.U. Omokaro, I. Ahonkha and J.A. Isibor, 2003. Prevalence of malaria parasitaemia and anaemia among pregnant women in warri, Nigeria. J. Med. Lab. Sci., 12: 53-58.

Jeremiah, Z.A., B. Koate, F. Buseri and F. Emelike, 2008. Prevalence of antibodies to hepatitis C virus in apparently healthy Port Harcourt donors and association with blood groups and other risk indicators. Blood Transfus., 6: 150-155.

Kagu, M.B., M.B. Kawuwa, A.O. Ayilara and B.Z. Ali, 2005. Seroprevalence of HIV and hepatitis viruses in directed blood donors: A preliminary report. Highland Med. Res. J., 3: 76-80.

Karuru, J.W., G.N. Lule, M. Joshi and O. Anzala, 2005. Prevalence of HCV and HCV/HIV co-infection among in-patients at Kenyatta National Hospital. East Afr. Med. J., 82: 170-172.

Keiser, J., J. Utzinger, M.C. de Castro, T.A. Smith, M. Tanner and B. Singer, 2004. Urbanization in sub-saharan Africa and implication for malaria control. Am. J. Trop. Med. Hyg., 71: 118-127.

Koate, B.B.D., F.I. Buseri and Z.A. Jeremiah, 2005. Seroprevalence of hepatitis C virus among blood donors in Rivers State, Nigeria. Transfus. Med., 15: 449-451.

Korenromp, E.L., B.G. Williams, S.J. de Vlas, E. Gouws, C.F. Gilks, P.D. Ghys and B.L. Nahlen, 2005. Malaria attributable to the HIV-1 epidemic, sub-saharan Africa. Emerg. Infect. Dis., 11: 1410-1419.

Lassey, A.T., N.K. Damale, V. Bekoe and C.A. Klufio, 2004. Hepatitis C virus seroprevalence among mothers delivering at the Korle-Bu Teaching Hospital, Ghana. East Afr. Med. J., 81: 198-201.

Lawal, O.A., A.S. Bakarey, L.N. Uche, A.O. Udeze and I.O. Okonko, 2009. Hepatitis B virus infection among prospective Human Immunodeficiency Virus positive blood donors at two designated blood banks in Ibadan, Nigeria. World Applied Sci. J., 7: 1269-1274.

Le Port, A., M. Cot, J.F. Etard, O. Gaye, F. Migot-Nabias and A. Garcia, 2008. Relation between *Plasmodium falciparum* asymptomatic infection and malaria attacks in a cohort of Senegalese children. Malaria J., 7: 193-193.

Lell, B., J. May, R.P. Schmidt-Ott, L.G. Lehman and D. Luckner *et al*., 1999. The role of red blood cell polymorphisms in resistance and susceptibility to malaria. Clin. Infect. Dis., 28: 794-799.

Macete, E., P. Aide, J.J. Aponte, S. Sanz, I. Mandomando and M. Espasa *et al*., 2006. Intermittent preventive treatment for malaria control administered at the time of routine vaccinations in Mozambican infants: A randomized, placebo-controlled trial. J. Infect. Dis., 194: 276-285.

Marcucci, C., C. Madjdpour and D. Spahn, 2004. Allogeneic blood transfusions: Benefit, risks and clinical indications in countries with a low or high human development index. Br. Med. Bull., 70: 15-28.

Mas J, A. Yumbe, N. Solo, R. Capole and T. Cremades, 1995. Prevalence, geographical distrituion and clinical manifestation of Onchocerciasis on the Island of Bioko. Trop. Med. Parasitol., 46: 13-18.

Matee, M.I. and P.M. Magesa, E.F. Lyamuya, 2006. Seroprevalence of human immunodeficiency virus, hepatitis B and C viruses and syphilis infections among blood donors at the Muhimbili National Hospital in Dar es Salaam, Tanzania. BMC Public Health, 6: 21-21.

Matee, M.I., E.F. Lyamuya, E.C. Mbena, P.M. Magessa and J. Sufi *et al*., 1999. Prevalence of transfusion-associated viral infections and syphilis among blood donors in Muhimbili Medical Centre, Dar es Salaam, Tanzania. East Afr. Med. J., 76: 167-171.

Mbanugo, J.I. and S.E. Emenalo, 2004. Prevalence of malaria parasitaemia among blood donors in owerri: Imo State, Nigeria. Nig. J. Parasitol., 25: 75-80.

Muktar, H.M., A.M. Suleiman and M. Jones, 2005. Safety of blood transfusion: Prevalence of Hepatitis B surface antigen in blood donors in Zaria, Northern Nigeria. Nig. J. Surgical Res., 7: 290-292.

Musi, S.S., L.M. Monny, N.E.C. Ndjitoyap, L. Tsague and L. Menyeng *et al*., 2004. Prevalence of transfusion transmitted infectious agents among healthy blood donors in Cameroon. Proceedings of the International Conference on AIDS, July 11-16, National AIDS Control Committee, Yaounde, Cameroon, pp: 15-15.

Mustapha, S.K. and Y.B. Jibrin, 2004. The prevalence of hepatitis B surface antigenaemia in patients with human immunodeficiency virus (HIV) infection in Gombe, Nigeria. Ann. Afr. Med., 3: 10-12.

Muula, A.S., 2000. Tackling HIV/AIDS in Africa-another perspective. Afr. Health, 23: 5-6.

Nelson, C.G., M.A. Iler, C.W. Woods, J.A. Bartlett and V.G. Fowler Jr., 2000. Meningococcemia in a patient coinfected with hepatitis C virus and HIV. Emerg. Infect. Dis., 6: 646-648.

Nmor, J.C. and A.O. Egwunyenga, 2004. A survey of blood parasites among blood donors at Eku, Delta State, Nigeria. Nig. J. Parasitol., 25: 87-92.

Nwabuisi, C., C.I. Aderinola and O.G. Ibegbulam, 2005. The seroprevalence of syphilis in unscreened and unstored blood transfused in Ilorin, Nigeria. Medipharm Med. J., 2: 7-9.

Ogunro, P.S., D.A. Adekanle, F.F. Fadero, T.O. Ogungbamigbe and S.O. Oninla, 2007. Prevalence of anti-hepatitis C virus antibodies in pregnant women and their offspring in a tertiary hospital in Southwestern Nigeria. J. Infec. Dev. Ctries., 1: 333-336.

Okafor, H.U. and T. Oguonu, 2006. Epidemiology of malaria in infancy at Enugu, Nigeria. Nig. J. Clin. Practice, 9: 14-17.

Okocha, E.C., C.C. Ibeh, P.U. Ele and N.C. Ibeh, 2005. The prevalence of malaria parasitaemia in blood donors in a Nigerian teaching hospital. J. Vector-Borne Dis., 42: 21-24.

Olokoba, A.B., F.K. Salawu, A. Danburam, O.O. Desalu and L.B. Olokoba *et al*., 2009. Viral hepatitides in voluntary blood donors in Yola, Nigeria. Eur. J. Sci. Res., 31: 329-334.

Opaleye, O.O., T.O. Zakariyahu, B.A. Tijani and A.S. Bakarey, 2010. HBV, HCV co-infection among blood donors in Nigeria. Indian J. Pathol. Microbiol., 53: 182-183.

Oronsaye, F.E. and J.I. Oronsaye, 2004. Prevalence of HIV-positives and hepatitis B surface antigen-positives among donors in the University of Benin Teaching Hospital, Nigeria. Trop. Doctor, 34: 159-160.

O'Meara, W.P., D.L. Smith and F.E. McKenzie, 2006. Potential impact of intermittent preventive treatment (IPT) on spread of drug-resistant malaria. PLoS Medicine, 3: 141-141.

RBM, 2005. Facts about Malaria in Nigeria, Abuja. Publication of the Roll Back Malaria, Abuja, Nigeria, pp: 1-2.

Rebecca, S.N., D.O. Akinboye and A.A. Abdulazeez, 2008. Onchocerciasis and plasmodiasis: Concurrent infection in Garaha-Dutse community, Adamawa State Nigeria. Biomed. Res., 19: 107-111.

Salawu, L. and H.A. Murainah, 2006. Pre-donation screening of intending blood donors for antibodies to infectious agents in a Nigerian tertiary health institution: A pilot study. Afr. J. Med. Med. Sci., 35: 453-456.

Sharara, A.I., C.M. Hunt and J.D. Hamilton, 1996. Hepatitis C. Ann. Internal Med., 125: 658-668.

Shrestha, A.C., P. Ghimre, B.R. Tiwari and M. Rajkarnikar, 2009. Transfusion-transmissible infections among blood donors in Kathmandu, Nepal. J. Infect. Dev. Ctries., 3: 794-797.

Simpore, J., D. Ilboudo, A. Samandoulougou, P. Guardo, P. Castronovo and S. Musumeci, 2005. HCV and HIV Co-Infection in pregnant women attending St. Camille Medical Centre in Ouagadougou (Burkina Faso). J. Med. Virol., 75: 209-212.

Snow, R.W., C.A. Guerra, A.M. Noor, H.Y. Myint and S.I. Hay, 2005. The global distribution of clinical episuode of *Plasmodium falciparum* malaria. Natls., 434: 214-217.

Stevens, C.E., P.E. Taylor, J. Pindyck, Q.L. Choo, D.W. Bradley, G. Kuo and M. Houghton, 1990. Epidemiology of hepatitis C virus. J. Am. Med. Assoc., 263: 49-53.

Trung, H., W. van Bortel, T. Sochantha, K. Keokenchanh, N. Quang, L. Cong and M. Coosemans, 2004. Malaria transmission and major malaria vectors in different geographical areas of Southeast Asia. Trop. Med. Int. Health, 9: 230-237.

UNICEF, UNAIDS, WHO, 1998. HIV and Infant Feeding: Guidelines for Decision Makers. WHO/FRH/UNT 98.1, UNAIDS/98.3, Geneva.

Udeze, A.O., I.O. Okonko, E. Donbraye, W.F. Sule, A. Fadeyi and L.N. Uche, 2009. Seroprevalence of Hepatitis C antibodies amongst blood donors in Ibadan, Southwestern, Nigeria. World Applied Sci. J., 7: 1023-1028.

Ufomadu, G.O., B.E.B. Nwoke and J.I. Akoh, 1991. The occurrence of loisis, mansonelloisis and wuchereriasis in the Jarawa river valley, central Nigeria. Acta Trop., 48: 137-147.

Umeanaeto P.U. and I.M. Ekejindu, 2006. Prevalence and intensity of malaria in blood donors at Nnamdi Azikwe University Teaching Hospital (NAUTH) Nwewi, Anambra State, Nigeria. Nig. J. Parasitol., 27: 11-15.

Umolu, P.I., L.E. Okoror and P. Orhue, 2005. Human immunodeficiency virus (HIV) seropositivity and hepatitis B surface antigenemia (HBsAg) among blood donors in Benin City, Edo state, Nigeria. Afr. Health Sci., 5: 55-58.

Usip, L.P., K.N. Opara, E.S. Ibanga, L.A. Atting and E. Uttah, 2006. Clinical Onchocerciasis in Ini Local Govern-ment Area, Akwa Ibom, Nigeria. Nig. J. Parasitol., 27: 36-40.

Van Benthem, B., S.O. Vanwambeke, N. Khantikul, C. Burghoorn-Maas, K. Panart *et al*., 2005. Spatial patterns of and risk factors for seropositivity for dengue infection. Am. J. Trop. Med. Hyg., 72: 201-208.

WHO, 1996. World Health Report. World Health Organization, Geneva, Switzerland.

WHO, 2005a. Making every mother and child count. The World Health Report, WHO, Geneva.

WHO, 2005b. WHO World Malaria Report. World Health Organization, Geneva.

WHO, 2006. The Africa Malaria Report. World Health Organization.

WHO, 2008. WHO World Malaria Report. World Health Organization, Geneva. WHO/HTM/GMP/2008.1.

WHO, 2010. Malaria. WHO Fact Sheet No. 94.

WHS, 2006. World Health Statistics. NHS, Nigeria Fact Sheet, No. 3, pp: 7

Warhurst, D.C. and J.E. Williams, 1996. Laboratory diagnosis of malaria: ACP Broadsheet No. 148. J. Clin. Pathol., 49: 533-538.

Weather, D.J., L.H. Miller, D.I. Baruch, K. March, O.K. Doumbo, C. Casals-Pascual and D.J. Roberts, 2002. Malaria and red cell. Haematol. Am. Soc. Haematol. Educ. Program.