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Research Article

Asymptomatic carriage of *Plasmodium* spp. and blood microfilariae among blood donors at the National Blood Transfusion Center (NBTC) in Abidjan in 2022

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ABSTRACT

Blood transfusion can be the source of transmission of blood-borne parasites. However, in Côte d'Ivoire, endemic blood-borne parasites such as microfilariae and *Plasmodium* are not tested during blood donations. The aim of this study was to contribute to transfusion safety by testing blood donors for *Plasmodium* and microfilariae. A cross-sectional study was carried out from June 20 to July 20, 2022, at the National Blood Transfusion Centre in Abidjan (Côte d'Ivoire). It concerned the donors of this center. For each donor who agreed to take part in the study, a blood smear, a thick drop, and a leuko-concentration test using the modified Knott technique were performed. A total of 369 donors took part in the study, including 321 men. The average age of blood donors was 36. The prevalence of asymptomatic carriage of *Plasmodium* spp. was 2.7%, with a mean parasite density of 2233.1 trophozoites per µL of blood. The only plasmodial species found was *Plasmodium falciparum*. No bloodstream microfilariae were found. Only 21.7% of donors used impregnated mosquito nets, while 39.3% occasionally used indoor residual spraying. No link was found between asymptomatic malaria parasite carriage and the socio-demographic characteristics investigated. Asymptomatic carriage of malaria parasites is a reality among blood donors in Côte d'Ivoire. It is therefore necessary to implement measures to combat post-transfusion malaria.

Keywords: Blood donors, *Plasmodium* Spp., Blood borne microfilariae, National blood transfusion center, Blood transfusion

INTRODUCTION

Blood is a liquid organ essential to human life. There are many situations in which a patient's condition requires them to receive blood to replace their deficiency as a matter of urgency. Blood transfusion is then used because blood is a medicine that humans do not yet know how to manufacture (Antwi-Baffour et al., 2019). As a result, blood transfusion makes an undeniable contribution to healthcare systems. Hence the need for states to have a large quantity of blood bags to ensure self-sufficiency in blood products and derivatives. However, this quantity of blood is of little use if the blood collected is not of the desired quality and safety for patients (Garraud et al., 2005; WHO, 2022). The WHO has therefore drawn up a list of pathogens of public health

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concern, which must be investigated as part of transfusion safety. These include Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV) and syphilis (Epstein and Holmberg, 2010; Bassandja at al., 2014; Morona et al., 2017). However, this is not an exhaustive list but a minimum list. Each country, depending on its health situation, should be able to expand the number of diseases to be screened. In Canada, Chagas disease has been included in this list (MacDonald et al., 2012). As a result, any infection potentially transmitted by blood can be looked for at blood donations and blood drives, especially when it is a major health problem for the country concerned. Parasitoses such as malaria and filariasis meet these criteria. Moreover, post-transfusion malaria, discovered in 1884, is particularly common in endemic areas (Adusei and Owusu-Ofori, 2018, Antwi-Baffour et al, 2019). Previous studies have reported several cases worldwide, particularly in sub-Saharan Africa (Bruce Chwatt, 1982; Sitalata et al., 2020). In Côte d'Ivoire, as in many other African countries, although malaria and certain filariasis are endemic, blood donations are not screened for these diseases (Uneke et al., 2006). Blood transfusion may therefore be a transmission route for *Plasmodium* and other parasites such as blood-borne microfilariae, in particular *Mansonella perstans* and *Wuchereria bancrofti*.

The data available on this subject are old and few. These include studies by Doumbia in 1994 and Konaté in 2012 (Konaté et al, 2012; Doumbia, 1994) carried out at the National Blood Transfusion Center (NBTC) in Abidjan. With the aim of updating and enriching the data in a context of intensified integrated control of mosquito-related diseases, we thought it would be interesting to carry out this study to determine the prevalence of asymptomatic carriage of plasmodia and blood-borne microfilariae among blood donors at the Abidjan NBTC. This information may be useful in considering possible interventions, in particular screening for blood-borne parasites during blood donations.

MATERIALS AND METHODS

Study area

A cross-sectional study was conducted from 20/06/2022 to 20/07/2022 at the National Blood Transfusion Centre (NBTC) in Abidjan, on a fixed site and mobile site in Abidjan, on fixed and mobile sites. The NBTC has a fixed site located in Treichville, at km 4 of Boulevard de Marseille in the commune of Treichville. However, the centre regularly travels to collect blood at the request of groups or organizations. Our study also covered these blood drives away from the fixed site.

Patients

The sample size of 369 patients was calculated using the Schwartz formula ($N=E^2PQ/I^2$) based on an estimated malaria prevalence (P) of 40% and a desired precision (I) of 5%. All regular or occasional blood donors, regardless of sex, received by the Abidjan NBTC during the study period for their donation and who agreed to participate in the study were included. For each participant, approximately 3 mL of venous blood was collected in a tube containing EDTA (violet-stoppered tube) for testing for *Plasmodium* and blood borne microfilariae at the Parasitology-Mycology laboratory of the Medical Sciences Training and Research Unit of the University Félix Houphouët Boigny in Abidjan. Sociodemographic data and other relevant information were collected using a well-structured survey form.

Laboratory examination

Once in the laboratory, the following tests were carried out on each sample:
For malaria:

- A thick air-dried drop then stained with Giemsa.
- A thin blood smear air-dried then fixed in methanol before staining with Giemsa.

These different smears were examined under a light microscope using an immersion objective (x100). Reading was carried out independently by 2 experienced microscopists to ensure concordance. Any discrepancies in the results were resolved by examination by a third microscopist. Parasite densities on the thick blood smear were estimated by counting the number of asexual parasites per 200 white blood cells and converted to parasites per mL assuming a total leukocyte count of 8,000 per mL of blood. The thin blood smear was used to identify the plasmodial species involved.

For blood microfilariae: Leuco-concentration (haemolys-concentration) using the modified Knott technique. After homogenisation, 1 mL of whole blood was mixed with 9 mL of 2% formalin. The mixture was centrifuged at 2500 rpm for 10 minutes. The supernatant was decanted, and the entire centrifugation pellet was observed between slide and coverslip under a light microscope (Anofel, 2017; Kindé-Gazard et al, 2021).

Data analysis

Statistical analysis was performed with EPI-INFO version 3.5.4. Probability values were statistically significant when the calculated p-value was equal to or less than 0.05. The difference among the different categories was compared using the Pearson's *chi-square* test (χ^2) and Fisher's exact test, where appropriate.

RESULTS

Sociodemographic characteristics of participants

A total of 369 donors took part in this study, 321 of whom were men, giving a sex ratio of 6.7. The average age of the blood donors was 36, with extremes of 18 and 62. Donors under the age of 50 accounted for 93.3% of cases. Regular donors, *i.e.* those who made at least 2 donations per year, accounted for 71.3% of cases, while only 21.7% of all participants used insecticide-treated mosquito nets.
Table 1 shows all the socio-demographic characteristics of the participants.

Variables	Frequency	Percentage
Age (years)		
18-35	169	45.8
36-50	168	45.5
>50	32	8.7
Total	369	100
Sex		
Male	321	87
Feminine	48	13
Total	369	100
Regular	263	71.3
Casual	106	28.7
Total	369	100
Use of the impregnated mosquito net		
Yes	80	21.7
No	289	78.3
Total	369	100
Occasional indoor spraying		
Yes	145	39.3
No	224	60.7
Total	369	100

Table 1. Sociodemographic characteristics of participants.

Carriage of malaria parasite (*Plasmodium*)

The prevalence of asymptomatic carriage of *Plasmodium* spp. was 2.7%. There was no association between gender and malaria parasite carriage (p=0.774); (Table 2). There was also no association between the use of impregnated mosquito nets and the carriage of *Plasmodium* (p=0.895).

Table 2 summarises the prevalence of *Plasmodium* carriage according to socio-demographic data.

The mean parasite density was 2233.1 trophozoites per µL of blood, with extremes of 284 and 9847 trophozoites per µL of blood. *Plasmodium falciparum* was the only species encountered.

Variables	Positive (%)	Negative (%)	Total	p -value
Sex				
Male	9 (2.8)	312 (97.2)	321	
Feminine	1 (2,1)	47 (97.9)	48	0.774
Total	10	359	369	
Type of donors				
Casual	4 (3.8)	102 (96.2)	106	
Regular	6 (2,3)	257 (97.7)	263	0.424
Total	10	359	369	
Use of the impregnated mosquito net				
Yes	2 (2.5)	78 (97.5)	80	
No	8 (2.8)	281 (97.2)	289	0.895
Total	10	359	369	

Table 2. Prevalence of *Plasmodium* carriage according to sociodemographic data.

Carriage of blood microfilariae

No species of blood microfilariae were found during this study.

DISCUSSION

All health systems need to have large quantities of blood products and blood derivatives to meet the transfusion needs of their populations. However, these blood products are of little use if they are not of the required quality and safety.

In other words, an adequate supply of safe blood is essential to reduce mortality and morbidity, particularly among young children and pregnant women (Owusu-Ofori et al., 2013). Consequently, it is important to strengthen blood safety by screening blood donations, the disease content of which may vary from one country to another.

The aim of this study was to assess the asymptomatic carriage of *Plasmodium* and blood borne microfilariae among blood donors in Côte d'Ivoire in a context of intensified integrated mosquito-borne disease control.

Sociodemographic characteristics of blood donors

Women represented only 13% of donors, compared with 87% men, giving a sex ratio of 6.7. This preponderance of men is also found in other African countries, notably in the Democratic Republic of Congo, where Kakisingi found 83.14% men, with a sex ratio of 4.93 (Kakisingi et al., 2016). This trend has also been found in Tanzania (Morona et al., 2017) and Nigeria (Olawuni et al., 2015; Wariso and Oboro, 2015). However, in the developed countries of Europe, we are seeing a different trend. According to EFS data, the sex ratio was less than 1 in France in 2020 (EFS, 2021). In other words, in these countries, there are as many or more female donors as male donors. In view of these results, there seems to be a reluctance on the part of women to donate blood in our geographical area (Africa). Could this reluctance be linked to cultural reasons and prejudices that would lead people to believe that it is dangerous for women to donate blood, because of motherhood and the menstrual cycle? Or is it linked to the level of schooling? Africa has one of the highest illiteracy rates among women. Whatever the answer to these questions, given the proportion of women in our general population, self-sufficiency in blood products and derivatives cannot be achieved without their effective participation. Consequently, there is a need to step up awareness-raising among women and to draw the attention of feminist organisations so that, in their struggles for women's empowerment and rights, they do not forget the social responsibilities of women, who must contribute as much as men to meeting all the challenges facing the country.

The average age was 36. Donors under 50 accounted for 93.3% of cases. This result, like those of Kakisingi in the DRC (Kakisingi et al., 2016) and Morona in Tanzania (Morona et al., 2017), shows that donors in Côte d'Ivoire are relatively young. This youth of donors, which is certainly related to the age pyramid of Côte d'Ivoire, could be an asset for achieving self-sufficiency in blood products and derivatives. In fact, at this age, the contraindications and contraindications to donation are not very common.

Use of the impregnated mosquito nets

Most blood donors (78.3%) did not use impregnated mosquito nets as a prophylactic measure. These donors were therefore exposed to mosquito-borne diseases. Our results are similar to those of Konaté, who found that only 18.1% of donors slept under impregnated mosquito nets (Konaté et al., 2012). It is true that in this study we were interested in malaria and filariasis, but many other serious and potentially fatal diseases can be transmitted by mosquitoes in tropical areas such as Côte d'Ivoire. These include yellow fever, dengue fever, the Zika virus, etc. These diseases can have a negative impact on the number of donors. As a result, the low uptake of Long-Lasting Impregnated Mosquito Nets (LLINs) puts blood donors and the blood and blood products management system at risk. Apart from the inconvenience caused by the nets, one of the reasons why they are underused is their unavailability. Blood donation can be an ideal setting for free distribution and awareness-raising.

Asymptomatic carriage of *plasmodium*

Of the 369 donors, 10 were infected with *Plasmodium*, a prevalence of 2.7%. The mean parasite density was 2233.1 with extremes of 284 and 9847 trophozoites per µL of blood. These results suggest that blood transfusion contributes to the spread of malaria in Côte d'Ivoire. The methods used to treat blood bags do not destroy the asexual forms of malaria parasites. Furthermore, no plasmodial research is carried out on the blood bags to be transfused. Consequently, the risk of transmitting malaria when the blood bag is infested is not negligible. Although cases of post-transfusion malaria are poorly reported in most malaria-endemic countries, prevention is recommended. This involves either eliminating suspected cases from blood donation or administering antimalarial treatment systematically to all recipients or when a fever develops after a blood transfusion (Antwi-Baffour et al., 2019; WHO, 2021). Ideally, all blood donors should be systematically screened for malaria, as some studies have suggested (Uneke et al., 2006; Bassandja et al., 2014). However, given our relatively low prevalence (2.7%), we question the relevance and viability of such a screening strategy, which would undoubtedly be cumbersome and costly. Also, would it be acceptable in our context of shortage of blood products and derivatives to reject a blood bag because it might contain plasmodia?

In Cote d'Ivoire, our results are like those of Konate in 2012 in Abidjan and Kouakou in 2023 in Bouaké, who observed prevalences of 1.4% and 3.5% respectively (Konaté et al., 2012; Kouakou et al., 2023). In Tanzania, Morona found a prevalence of asymptomatic carriage of *Plasmodium* in blood donors of between 5.3% and 8%, depending on the diagnostic technique used (Morona et al., 2017), while Rakotoniaina reported 1.5% in Madagascar (Rakotoniaina et al., 2017). Other authors in Africa found higher prevalences. This is the case for Bassandja in the DRC, who observed a prevalence of asymptomatic carriage of 28.3% (Bassandja et al., 2014). In Burkina Faso, Guiguemdé reported a prevalence of 50.7% in 1995, while Kindé-Gazard in

Benin in 2000 and Erhabor in Nigeria in 2007 reported prevalences of 33.5% and 10.2% respectively (Konaté et al., 2012). These high rates can be explained by the study period. In fact, the work of Guiguembe, Kinde and Erhabor dates back more than 15 years; the fight against malaria had not reached this level of intensity, and consequently national malaria prevalences were higher than they are now.
In Ghana, Adusei et al. and Ezeonu et al. in Nigeria found rates of 3% and 45.8% respectively (Adusei et al., 2018; Ezeonu et al., 2019).

In this study, *Plasmodium falciparum* was the only species observed. This observation is consistent with data in the literature. According to the Côte d'Ivoire National Malaria Control Programme (NMCP), *Plasmodium falciparum* accounts for 95% of the plasmodial species involved in malaria attacks (PNLP, 2023).

Microfilaria and blood transfusion

No microfilaria was found in any of the 369 samples. There are several possible reasons for this finding. Firstly, this result could reflect a low prevalence of the various microfilaria sought. Although Côte d'Ivoire is recognised as an endemic area for *Wuchereria bancrofti* and *Mansonella Perstans*, Konaté in 2012 found only one microfilaria per 1000 donors. Previously, Doumbia in 1994 found 1.3% *Mansonella Perstans* and 0.1% Loa loa (Konaté et al., 2012; Doumbia, 1994). Secondly, these results could be related to the time of sampling. *Wuchereria Bancrofti*, one of the filaria sought, has microfilaria with nocturnal blood periodicity. As a result, nocturnal samples are more sensitive, whereas our samples were taken during the day. Finally, the modified KNOTT technique used in the study may be less sensitive than other techniques, particularly the HO THI SANG technique, due to the small quantity of blood used. It is important to note that the presence of symptomatic filariasis is a contraindication to blood donation in Côte d'Ivoire. However, in current practice, no research is carried out. It would therefore seem worthwhile including a search for microfilariae before any blood donation.

CONCLUSION

This study showed that blood donors received at the NBTC in Abidjan Côte d'Ivoire are asymptomatic carriers of *Plasmodium* spp. Consequently, blood transfusion in Côte d'Ivoire is a potential source of transmission and spread of malaria. Given the absence of *Plasmodium* testing during blood donations, it would be advisable to focus on raising doctors' awareness with a view to preventively treating transfused patients or monitoring for the appearance of fever after transfusion. This study could be continued over an entire year and across the whole country to assess seasonal and geographical variations in this asymptomatic carriage.

ETHICAL CONSIDERATION

This cross-sectional study looking for microfilariae and plasmodia in blood donors was carried out in compliance with the rules of confidentiality and with the authorisation of the management of the NBTC. The survey did not interfere with any laboratory analysis or results reporting procedures. The report on this survey was sent to the management of the said centre.

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