

Asymptomatic Malaria during Blood Transfusion in N'Djamena, Chad: Associated Risk Factors among Blood Donors

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| Received: 05.12.2023 | Accepted: 09.01.2024 | Published: 12.01.2024

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Abstract

Original Research Article

Background: Malaria is a parasitic disease transmitted to humans through the bite of a female mosquito (Anopheles). However, blood transfusion, which is a life-saving medical procedure in many settings, represents a potential route of *Plasmodium* transmission. The objective of this study was to determine the plasmodial parasitemia in blood donors with a view to assessing the quality of the erythrocyte concentrates produced at the National Blood Transfusion Center (CNTS) of Chad. **Methods:** This was a cross-sectional analytical study involving 271 subjects who came to donate blood at the CNTS in N'Djamena over a period from March 1 to June 1, 2023. After obtaining the tacit and/or informed consent of potential donors, a questionnaire was administered to them to collect sociodemographic data, knowledge and practical attitudes towards malaria. A blood sample was taken from each individual. The following biological analyzes were carried out: Malaria Rapid Diagnostic Test, thick smear, blood smear. Data were entered and analyzed using SPSS software version 26.0, and the Chi square test was used to compare proportions and a logistic regression model to look for risk factors associated with malaria infection. **Results:** This study reveals that: the most represented age group was that of 18-28 years (68.6%), with a sex ratio of 4.1 in favor of the male sex, family type donors were more represented (73.4%). The prevalence of plasmodial infection was 12.2% with a parasitemia of between 100 and 600 parasites/ μ L of blood. The species in question was *Plasmodium falciparum*. A statistically significant association was established between sex, non-use of insecticide-treated mosquito nets, lack of knowledge about malaria and malaria infection. **Conclusion:** This work showed that the residual transfusion risk of malaria is real at the CNTS. It would therefore be necessary to ultimately adopt an innovative safety strategy including systematic screening of donations for *Plasmodium falciparum*.

Keywords: Malaria infection, blood transfusion blood donors, Chad.

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1. INTRODUCTION

Malaria is a parasitic blood disease caused by a protozoan of the genus *Plasmodium* and transmitted to humans through the bite of a mosquito, the female Anopheles, during its blood meal.

It is a febrile hemolytic disease which is endemic in tropical and subtropical zones (Vincent Robert, 2022). Its negative socio-economic impact and its high morbidity and mortality make it a major public health problem (WHO, 2021). Indeed, at the global level, according to the World Health Organization (WHO) report, there were 247 million cases of malaria in 2021 compared to 245 million in 2020; the estimated number of deaths attributable to malaria rose to 619,000 in 2021

compared to 625,000 in 2020 (WHO, 2003, WHO, 2008).

The WHO African Region continues to bear a large and disproportionate share of the global malaria burden. This parasitosis is a vector-transmitted condition whose vector known as anopheles belongs to the Culicidae family (Olandipradines and Corbel, 2007). Malaria can be effectively transmitted through blood transfusion and is undoubtedly responsible for the majority of diseases transmitted by blood transfusion, making this human act intended to save a life, instead endangering it. Several recent studies carried out in West Africa, East Africa and the Middle East show the importance of the transfusion risk of malaria (Kinde-Gazard *et al.*, 2000; Okocha *et al.*, 2005); Kandolfi,

Citation: Mbanga Djimadoum, Bessimbaye Nadlaou, Maoundié Magloire. Asymptomatic Malaria during Blood Transfusion in N'Djamena, Chad: Associated Risk Factors among Blood Donors. Sch J App Med Sci, 2024 Jan 12(1): 57-63.

2005). This raises both concern for our health system and the interest in carrying out research in this area. The prevalence of malaria infection among blood donors in sub-Saharan Africa is estimated between 14 and 29%, making *Plasmodium* the first infectious agent transmissible by blood transfusion compared to other agents such as the immunodeficiency virus, human, hepatitis C virus and hepatitis B virus, the prevalence of which is estimated between 0.5-16%; 0.5-3% and 5-25% respectively (Ahmadpour *et al.*, 2019).

In Chad, malaria ranks first among the conditions affecting communities, it is the leading reason for consultation (40.6%), the leading cause of hospitalization (36.26%) and hospital deaths. (35.98%). The death rate of children under 5 years old and pregnant women is estimated at more than 70% (Chad-PND, 2020). If in developed countries it is part of systematic screening on all donations, it does not receive the same attention in Africa and in the same way as HIV, HBV and syphilis, and is therefore little or not included in the procession of infections transmitted by transfusion to be systematically searched for. A preliminary study carried out in 2012 as part of an end-of-cycle thesis at the CNTS in N'Djamena places the frequency of malaria at around 35%. Ten years later, it seems appropriate to ask new questions about the real risk of Plasmodium transmission among recipients at the National Blood Transfusion Center of N'Djamena (CNTS). It is in this context that this work was carried out with a view to determining plasmodial parasitemia in blood donors in order to assess the quality of the erythrocyte concentrates produced and distributed by CNTS of Ndjama.

2. MATERIAL AND METHODS

2.1. Study setting

This study was carried out at the National Blood Transfusion Center (CNTS) in N'Djamena, Chad. The CNTS is a structure in charge of the collection, preparation and distribution of labile blood products in most hospitals in N'Djamena.

2.2. Type and period of study

The study took place over a period of three (03) months, going from March to June 2023. It was an analytical cross-sectional study covering all the subjects who presented themselves for a donation whatever the type (voluntary or family) and who have consented to participate in the study.

2.3. Study population

The people who were included in the present study gave their tacit and/or informed consent, and met the conditions of suitability for donation in force at the CNTS, without distinction of sex, socio-cultural, socio-economic conditions.

2.4. Eligibility criteria

Were included in our study, adults aged 17 to 60 years who were judged fit (physical examination in particular blood pressure (BP), hemoglobin (Hb) greater than or equal to 12 in men and greater than or equal to 11 in women; weight greater than or equal to 50 kg and having given their consent.

Any participant who provided incomplete or unusable information was excluded from this study.

2.5. Collection tools

A questionnaire sheet was used to collect the variables of interest, in this case, age, sex, results of thick blood film, parasite density and plasmodial species.

2.6. Analysis techniques

A capillary blood sample served as a sample for analyses. A rapid diagnostic test (RDD SD Bioline-Malaria-Ag Pf Pan) was carried out on the participants, when it was positive a thick smear was made to determine the intensity of infection, then a smear to determine the species. Parasitemia was assessed by counting asexual parasites per 200 leukocytes, i.e. an assessment for one microliter of blood (assuming an average of 8,000 leukocytes per microliter).

2.7. Statistical Analysis

The data were analyzed by SPSS 26.0 software. The Chi square test and Student test were carried out to search for a statically significant relationship ($p < 0.05$).

2.8. Ethical considerations

During collection, a questionnaire is provided to the donor with information about the research objective. All candidates for donation are reminded of anonymity, volunteerism, volunteering, respect for the human person in their opinions, in their decisions, with informed and adopted information.

3. RESULTS AND DISCUSSION

We included 271 donors in the present study, which aimed to determine plasmodial parasitemia in blood donors with a view to evaluating the quality of erythrocyte concentrates distributed at the National Blood Transfusion Center of Chad. The patients were interviewed and had a blood sample taken. The results obtained recorded in the figures and tables.

3.1. RESULTS

3.1.1. Sociodemographic characteristics

The study involved 271 subjects who came to donate blood at the CNTS in N'Djamena. The average age of donors varies between 18 and 64 years with (68.6%) predominance in the age group of 18-28 years and a sex ratio of 4.01 in favor of male sex (80.1%). The socio-professional class most represented in our study is that of students (35.1%) followed by the informal sector

(42.5%) compared to a minority in the formal sector (22.5%).

Table 1: Distribution of donors according to sociodemographic characteristics

Parameter	Effective	Percentage (%)
Sex		
Male	217	80.1
Female	54	19.9
Age		
[18-28]	186	68.6
[29-35]	56	20.7
[36-45]	25	9.2
>46	4	1.5
Occupation		
Formal sector	61	22.5
Students/Pupils	95	35.1
Informal sector	115	42.5
Religion		
Christian	117	43.2
Muslim	147	54.2
others	7	2.6
Marital status		
Married	149	55
Bachelor	122	45
Total	271	100

3.1.2. Overall prevalence of plasmodial infection among blood donors

In total, 33 donors tested positive compared to 238 donors who tested negative, i.e. a plasmodial prevalence of 12.2%. Among the positive samples, only one species of *Plasmodium* was found, it was *Plasmodium falciparum*. parasite density ranged from 100 to 660 trophozoites/mm³ of blood.

3.1.3. Prevalence of plasmodial infection according to sociodemographic characteristics of study participants

Table 2 presents the prevalence of malaria according to sociodemographic characteristics. It appears from this table that there was no significant association between age, profession and malaria carriage ($p>0.05$). The prevalence was highest in the 18-28 age group with 7.4%, followed by the 29-35 age group with a prevalence of 3.7%. The least affected age group was 36-45 years old with a prevalence of 1.1%. However, it reveals that men (7.4%) were more parasitized than women (4.8%). There is therefore a relationship between sex and malaria infection ($p=0.003$).

Table 2: Prevalence of plasmodial infection according to sociodemographic characteristics of study participants

Parameter	Number tested	Positive number	Prevalence (%)	p-value
Sex				
Male	217	20	7.4	0.003
Female	54	13	4.8	
Age				
[18-28]	186	20	7.4	0.458
[29-35]	56	10	3.7	
[36-45]	25	3	1.1	
>46	4	0	0	
Occupation				
Formal sector	61	6	2.2	0.488
Students/pupils	95	12	4.4	
Informal sector	115	15	5.6	
Marital status				

Parameter	Number tested	Positive number	Prevalence (%)	p-value
Married	149	18	6.6	0.694
Bachelor	122	15	5.6	
Total	271	33	12.2	

3.1.4. Prevalence of plasmodial infection according to main risk factors

The association between the main risk factors and malaria infection in donors is presented in Table 3. It appears from this table that the non-use of the long-acting insecticide-treated mosquito net (MILDA) (p

$=0.003$), and knowledge of the disease ($p=0.001$) are significantly associated with malaria infection ($p<0.05$). The prevalence of malaria infection was higher among those who did not use the MILDA (7.8%) and those who said they did not know the disease (10.7%).

Table 3: Prevalence of plasmodial infection according to the main risk factors

Parameter	Number tested	Positive number	Prevalence (%)	p-value
Knowledge of the disease				
Yes	263	4	1.5	0.001
No	8	29	10.7	
Using MILDA				
Yes	55	7	2.7	0.003
No	189	21	7.7	
Sometimes	27	5	1.8	
Use of insecticides				
Yes	43	8	2.2	0.698
No	228	25	10.0	
Habitat near Swamp				
Yes	32	28	1.8	0.525
No	239	5	10.4	
Total	271	33	12.2	

3.1.5. Risk factors associated with plasmodial infection among blood donors at the National Blood Transfusion Center of N'Djamena

Table 4 summarizes some risk factors related to *Plasmodium* carriage. Overall, it appears from this table that age, use of insecticides, occupation and living near a watercourse are not risk factors linked to asymptomatic

carriage of *Plasmodium* in blood donors at the National Blood Transfusion Center in N'Djamena. Furthermore, male gender ($p<0.05$), lack of knowledge about the disease and non-use of MILDA ($p=0.002$) are risk factors significantly associated with plasmodial infection ($p<0.05$).

Table 4: Risk factors associated with plasmodial infection among blood donors at the National Blood Transfusion Center of N'Djamena

Parameter	Number tested	Positive number	OR	IC à 95%	p-value
Sex					
Male	217	20	3.075	1.401-6.750	0.001
Female	54	13		-	-
Age					
[18-28]	186	20	1.250	1.033E7-1.749E8	0.189
[29-35]	56	10	2.636E7	7.104E7- 9.780E7	0.123
[36-45]	25	3	3.071E7	3.071E7-3.071E7	
>46	4	0	-	-	-
Occupation					
Formal sector	61	6	1.808	0.454-7.197	0.401
Students/pupils	95	12	1.485	0.1101-35.268	0.560
Informal sector	115	15	6.231	0.792-11.226	0.139
Knowledge of the disease					
Yes	8	4	1.124	0.029 – 0.522	0.001
No	263	29	-	-	-
Use of MILDA					

Parameter	Number tested	Positive number	OR	IC à 95%	p-value
Yes	55	7	1.550	0.188-2.606	0.002
No	189	21	0.642	0.183-2.248	0.488
Sometimes	27	5	-	-	-
Bedtime					
Before 10 p.m.	38	4	0.508	0.400-3.654	0.230
After 10 p.m.	233	29	-	-	-
Insecticides					
Yes	43	8	0.707	0.359 3.256	0.698
No	228	25	-	-	-
Swamp					
Yes	32	28	0.756	0.606 5.090	0.300
No	239	5	-	-	-

P: P-value; **OR:** Odd ratio; **n:** Effective, **IC:** 95% confidence interval

3.2. DISCUSSION

The main objective of the present study was to determine plasmodial parasitemia in blood donors with a view to evaluating the quality of erythrocyte concentrates distributed at the National Blood Transfusion Center of Chad.

In total, 271 participants were included in this study with the male gender predominantly represented (80.1%); i.e. a sex ratio of 4.01 and the most represented age group was 18-28 years old.

This study established an overall prevalence of plasmodial infection of 12.2%. This rate is much higher than those (4.41%) reported in a study carried out in Cameroon, precisely in Bafoussam on plasmodial parasitemia in labile blood products: quality of concentrates (erythrocytes) distributed to the Blood Transfusion Center of the Hospital Bafoussam regional (Ewondo, 2023). This difference in prevalence could be explained by the level of endemicity of the environment and the period during which the study was carried out. Indeed, it was found that the transmission of malaria occurs continuously in the city of N'Djamena in Chad, but with different intensities depending on the seasons, the period in which the study was carried out (March to June) corresponds during a period of low malaria transmission in Chad where the climate does not favor the survival of the malaria vector unlike Bafoussam which is a non-endemic area with low transmission. Furthermore, these results are completely comparable to that (11.78%) reported in a similar study carried out on asymptomatic carriage of *Plasmodium* among blood donors in Douala, Cameroon (Ndo, 2019). These differences in prevalence in the three cities (N'Djamena, Bafoussam, and Douala) could be due to climatic and demographic conditions. Furthermore, several studies carried out in Africa have reported higher prevalence, particularly in Burkina Faso, Benin and Nigeria, with respective rates of 50.7%, 33.5% and 51.5% (Bassandja, 2014; Kinde-Gazard, 2001). These rates can be explained by the fact that these countries are declared to

be the most affected by malaria in the world (WHO, 2003). The results of all these studies sufficiently indicate that the risk of plasmodial transmission through blood transfusion exists, which implies the taking of effective preventive measures.

Plasmodium falciparum was the only species found, which confirms the responsibility of this species in the occurrence of almost all malaria attacks in sub-Saharan Africa (Tagny, 2010). Studies carried out in Nigeria and Burkina Faso had also identified *Plasmodium falciparum* as the main species among blood donors (Ewondo, 2023; Ngane, 2009). These results agree with scientific reviews on the responsibility of *Plasmodium falciparum* in transfusional malaria: American studies reported a total of 93 cases of transfusional malaria between 1963-2000, of which six (6) deaths out of 10 were due to this species (Carne *et al.*, 2004); Ali *et al.*, 2005; Mungai *et al.*, 1999). In France, in 2002, the plasmodial species causing patient deaths was also *Plasmodium falciparum* (Elghouzzi and Garraud, 2006; Denis and Mouchet, 1991). The present study revealed a parasitemia varying between 100 to 660 Trophozoites/mm³ of blood. The occurrence of cases of post-transfusion malaria can be effective even for a parasitemia of less than 100 parasites per mm³ of blood considered low and is most often pathogenic in a deficient subject (Ngane, 2009). Indeed, it is well known that the age group 0 to 5 years, immunocompromised patients and pregnant women candidates for blood transfusion are the most vulnerable to malaria. This high demand is linked to the pathologies of children aged 0 to 5 years (lack of protection) which are dominated by malaria and anemia common among pregnant women (Tagny, 2010).

Analysis of risk factors revealed that gender, non-use of long-lasting insecticide-treated mosquito nets (MILDA) and lack of knowledge about the disease are risk factors significantly associated with plasmodial infection. Indeed, the use of the MILDA was reported by most blood donors, those who did not use the MILDA

and those who did not know the disease had a higher risk of asymptomatic carriage of *Plasmodium* than those who reported use of the impregnated mosquito net as well as those experiencing the disease. This result corroborates previous studies on the factors determining the vulnerability of the population to malaria, which revealed the lack of knowledge relating to malaria and the non-use of MILDA as being predisposing factors to the disease (Doumbia, 2021; Pryce *et al.*, 2018); Elghouzzi and Garraud, 2006). In terms of gender, a similar study conducted in Colombia reported that men were more parasitized than women, respectively 59% versus 41% (Yandi *et al.*, 2017). Indeed, this could be explained by the assigned roles which can lead men to work in the fields after dark or get up early in the morning for duty, thus exposing them to times when mosquitoes are most active.

Although evaluated during a period of low transmission and in an endemic area, the absence of systematic screening for *Plasmodium* in blood donors made it possible to list a plasmodial prevalence of 12.2%. The risk of malaria transmission by transfusion at the CNTS of N'Djamena in Chad is real and this constitutes a real health problem which deserves particular attention. From all of the above, to remain in accordance with the medical act which consists of transfusing blood without bringing other pathologies to the recipients, *Plasmodium* screening in pre-donation examinations constitutes a good alternative for good malaria prevention. Transfusion in the recipient, more particularly immunocompromised recipients, children under five years of age and pregnant women.

4. CONCLUSION

At the end of this study, the main objective of which was to determine plasmodial parasitemia in blood donors with a view to evaluating the quality of the erythrocyte concentrates produced and distributed by the National Blood Transfusion Center of Chad, it emerged that with a prevalence plasmodial infection of 12.2% in donors and a parasitemia of between 100 and 600 parasites/ μ l of blood, blood transfusion also remains one of the routes of transmission of malaria. A significant association was established between malaria infection, sex and non-use of MILDA in these donors at the National Blood Transfusion Center in N'Djamena.

From the above, it would be appropriate to consider the implementation of systematic screening for *Plasmodium falciparum* on blood donations in order to avoid optimizing and increasing transfusion safety, especially when we know that the main beneficiaries are often children, pregnant women and immunocompromised patients.

ACKNOWLEDGMENTS

The authors of this article extend their sincere thanks to the Management of the National Blood Transfusion Center (CNTS) in N'Djamena, Chad. A big thank you to the patients and blood donors for agreeing to participate in the study. May the staff of the CNTS biological qualification laboratory also find here the expression of our sincere gratitude.

Conflict of Interest: The authors declare no conflict of interest for this work.

Maoundié Magloire (MM), Developed and ensured the collection of the sample in the field, carried out the manipulation in the laboratory as well as the writing of the first draft.

Mbanga Djimadoum (MD), Directed the manipulation in the laboratory and contributed to the correction and scientific orientation of the writing.

Bessimbaye Nadlaou (BN), Coordinated the entire work.

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