

Full Length Research Paper

Seroepidemiology of *Toxoplasma gondii* Infection among Blood donors in Dakar

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Abstract

Background: Transmission of *Toxoplasma gondii* from blood donors to receiving patients has become a concern, as reported in several articles. This study aimed to determine the seroprevalence of toxoplasmosis in blood donors in Dakar. **Methods:** A cross-sectional study was conducted at the Military Hospital of Ouakam Blood transfusion center. Socio-demographic information and blood samples were taken from each participant. *T. Gondii* antibodies were screened by a chemiluminescent microparticle immunoassay method. **Results:** Overall, 204 blood donors were enrolled. The mean age was 33.1 ± 11.9 years, and 81.9% were male. The overall IgG seroprevalence was 33.3%. The highest seroprevalence was found in the 40-49 age group. Males (35.3%) were more afflicted than females (24.3%). The seroprevalence rate was comparable in militaries and civilians. The highest seroprevalence was recorded in participants having contact with cats. A remarkable variation in seroprevalence was found between blood types ranging from 20% for the AB-blood type to 48.7% for the B-blood type. **Conclusion:** The seroprevalence of toxoplasmosis in Senegalese blood donors is comparable to those reported previously in pregnant women. Although the risk of transfusion-transmitted toxoplasmosis still exists due to its relatively high prevalence, screening *T. gondii* in blood donations in Senegal may not be mandatory.

Keywords: Seroprevalence, Toxoplasmosis, blood donors, Senegal.

BACKGROUND

Toxoplasmosis is a zoonotic disease caused by a protozoan belonging to the Apicomplexa phylum called *Toxoplasma gondii*, an obligate and opportunistic intracellular coccidian (Fréchal et al. 2017; McFadden et Yeh 2017). Approximately one-third of the world's population is estimated to be infected with highly variable

prevalence rates, ranking from 7 to 80% (Foroutan-Rad et al. 2016; Rostami et al. 2020). However, the percentage of people seropositive for toxoplasma infection differs between countries according to cooking habits and hygienic requirements. Contamination occurs by ingestion of contaminated raw vegetables and undercooked infected meat. Cats are also a source of contamination for humans through their feces (Pinto-Ferreira et al. 2019; Smith et al. 2021). Toxoplasmosis infection is not transmitted from person to person except

in mother-to-child (congenital) transmission and blood transfusion or organ transplantation (Foroutan et al. 2018). The disease is usually asymptomatic in healthy individuals but can cause serious illness in people with weakened immune systems (Halonen et Weiss 2013). In patients with immunodeficiency or immunosuppressed (cancer chemotherapy or organ transplantation), toxoplasmosis can be activated by reactivating latent infection (Robert-Gangneux et Dardé 2012; Rafati-Sajedi et al. 2021). To this end, serological screening for toxoplasmosis among potential pre-transplant and transplant recipients is highly recommended. In addition, organ transplantation management may require blood transfusions. Therefore, blood transfusion safety should consider opportunistic pathogens such as *Toxoplasma gondii*. In Egypt and Turkey, it has been suggested that screening blood donors for toxoplasmosis to improve transfusion safety in patients undergoing immunosuppressive therapy (El-Sayed et al. 2016; Yilmaz, Yazıcı, et Turk 2021) whereas, in Tunisia and Ivory Coast, previous studies indicated that toxoplasmosis testing is unnecessary for blood donors. In Senegal, earlier studies on toxoplasmosis focused only on pregnant women (Lo et al. 2012; Tine et al. 2017; Seck, et al. 2015). In a framework of kidney transplantation, no data are available regarding toxoplasmosis seropositivity among blood donors. This study aimed to determine the seroprevalence of toxoplasmosis in blood donors to assess the risk of transmission associated with blood transfusion.

METHODS

Study site and population

This cross-sectional study was conducted from July to September 2022 at the Military Hospital of Ouakam. Recruitment of participants and *Toxoplasma* antibodies screening was conducted at the same hospital's blood transfusion center and the parasitology laboratory. The military hospital of Ouakam is a level 3 public hospital located in Dakar, the capital city of Senegal.

Data and samples collection

Only blood donors eligible for donation and who consented to be included in the study were recruited. No additional blood samples were collected for this study. In addition to HIV, hepatitis B, hepatitis C, and syphilis testing, we simultaneously screened participants for anti-*Toxoplasma gondii* antibodies using the same machine. In the blood donor questionnaire of the blood transfusion center, which provides socio-demographic information (age, gender, weight, address, and marital status), we added three questions regarding the risk factors associated with *T. gondii* infection: occupation, ingestion of undercooked meat and contact with cats.

Toxoplasma gondii antibodies detection

Serum samples were obtained by centrifuging the whole blood at 3000 rpm for 5 minutes. From serum samples, quantitative analysis of anti-*T.gondii* IgG and IgM antibodies were performed by a chemiluminescent microparticle immunoassay (CMIA) according to the manufacturer's instructions using Architect ci4100 (Abbott). Antibody test results were considered nonreactive (IgM < 0.50; IgG < 1.60 UI/ml), gray-zone (IgM: 0.50 to < 0.60; IgG: 1.60 to < 3.0), or reactive (IgM ≥ 0.60; IgG ≥ 3.0) as per the manufacturer's guidelines.

Statistical methods

Statistical analyses were performed using R software (R 4.1.2). Continuous variables were described as mean and standard deviation. Normally distributed variables were compared using the Student t-test, and abnormally distributed data were compared with the nonparametric Mann-Whitney test. Categorical variables were presented as percent, and Fisher exact or chi-squared tests were used for proportional assessments. Univariate logistic regression analysis assessed the association between the related risk factors and seropositivity. Data were split into four class ages, i.e., 19 - 29; 30- 39; 40- 49, and 50- 56 years, to enable statistical comparisons. We accepted a two-sided significance level at $p \leq 0.05$ for all statistical tests.

Ethical considerations

This study was validated and approved by the authorities of the Military Hospital of Ouakam and the institutional review boards of the army health department (NDS 03/05/22). Informed consent was obtained from each participant.

RESULTS

Characteristics of the blood donors

During the course of the study period, 204 blood donors were enrolled. The mean age (SD) was 33.1 years±11,9, and 81.9% were male. More than half of blood donors (53.9%) were aged between 19 and 30. Militaries represented 44.6% and civilians 55.4%. The majority (59.3%) were single, and 4.9% (n=10) reported having contact with cats. By blood type, 50% of the participants have blood type O. Undercooked meat consumption was not noted among blood donors. Other details of the study population are presented in **table I**.

Seroprevalence of toxoplasmosis

Of 204 blood donors included in this study, sixty-eight presented IgG toxoplasma antibodies (seroprevalence

Table 1: Sociodemographic characteristics of blood donors (N = 204).

	% [n]	95% CI
Age group (years)		
19 - 29	53.9% [110]	47 - 61
30 - 39	13.2% [27]	9.1 - 19
40 - 49	9.8% [20]	6.2 - 15
50 - 56	23% [47]	18 - 30
Blood group		
A	26% [53]	20 - 33
AB	4.9% [10]	2.5 - 9.1
B	19.1% [39]	14 - 25
O	50% [102]	43 - 57
Gender		
Female	18,1% [37]	13 - 24
Male	81,9% [167]	76 - 87
Statut		
Civilian	55.4% [113]	48 - 62
Military	44.6% [91]	38 - 52
Occupation		
State employee	74% [151]	67 - 80
No-formal sector	20.6% [42]	15 - 27
Student	5.4% [11]	2.9 - 9.7
Matrimonial status		
Married	40.7% [83]	34 - 48
Single	59.3% [121]	52 - 66
Cat with contact		
No	95.1% [194]	91 - 97
Yes	4.9% [10]	2.5 - 9.1
Undercooked meat consumption		
No	100 % [204]	98 - 101

33.3% [CI95%, 27 – 40]). None of them were positive for IgM antibodies. **Table 2** shows that the highest seroprevalence was found in blood donors aged between 40 and 49 years with 45% [CI 95%, 24 -68] and 50 – 56 age group with 34% [CI 95%,21-49]; although this was not statistically significant ($p=0.7$). The seroprevalence rate was higher in males than females, with 35.3% [CI95%, 28 – 43] and 24.3% [CI 95%,12 - 42], respectively. Toxoplasmosis seroprevalence is not statistically significant between militarys [28.6% (CI 95%, 20 – 39)] and civilians [37.2% (CI 95%, 28 – 47)] ($p=0.2$). Although any statistical difference was found in the distribution of seroprevalence by occupation, 54,5% of students presented IgG toxoplasma antibodies ($p=0.3$).

Similarly, the highest seroprevalence rate [50% (CI 95% (24 -76))] was recorded in participants having contact with cats ($p=0.3$) and married group with 36.1%[CI 95% 26 – 47].

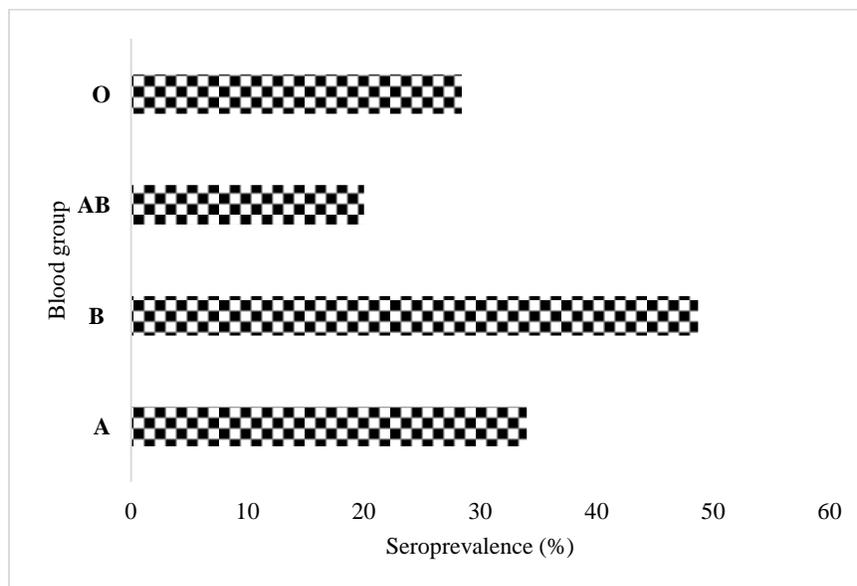
Also, a very high variation in toxoplasmosis seroprevalence was found between blood types ranging from 20% (CI 95% 3.5% - 56%) for the AB-blood type to 48.7% for the B-blood type (CI 95% 33 – 65) (**figure 1**).

DISCUSSION

This first study on toxoplasmosis among Senegalese healthy blood donors aimed to determine the seroprevalence of *T. gondii* infection and their associated

Table 2: Toxoplasmosis seroprevalence by sociodemographic characteristics of blood donors.

	IgG Positive, n (%)	95% CI	Overall, N = 211	p-value
Age group				
19 - 29	34 (30.9)	23 - 41	110	0.7
30 - 39	9 (33.3)	17 - 54	27	
40 - 49	9 (45.0)	24 - 68	20	
50 - 56	16 (34.0)	21 - 49	47	
Gender				
Female	9 (24.3)	12 - 42	37	0.2
Male	59 (35.3)	28 - 43	167	
Statut				
Civilian	42 (37.2)	28 - 47	113	0.2
Military	26 (28.6)	20 - 39	91	
Occupation				
State employee	47 (31.1)	24 - 39	151	0.3
No-formal sector	15 (35.7)	22 - 52	42	
Student	6 (54.5)	25 - 82	11	
Matrimonial status				
Married	30 (36.1)	26 - 47	83	0.5
Single	38 (31.4)	23 - 41	121	
Cat contact				
No contact	63 (32.5)	26 - 40	194	0.3
Contact	5 (50.0)	24 - 76	10	

**Figure 1:** Seroprevalence of toxoplasmosis by blood-type.

risk factors. The overall seroprevalence of 33,3% was recorded, and any positivity regarding IgM antibodies was noted. These findings indicated no active toxoplasmosis infection among the blood donors in this series, even if a third of the study population had previous contact with the parasite.

In Senegal, previous reports concerning toxoplasmosis were only focused on pregnant women. The overall seroprevalence in this study is comparable to those previously reported in Dakar, ranging from 28,9% to 35 %Lo et al. 2012; Tine et al. 2017; Seck et al. 2015; Mouhamadou et al. 2022). However, it remains lower when

comparing the seroprevalence of 24.3% found among women's blood donors with those recorded in pregnant women. The explanation may be due to the low number of women representing only 18.1% (n=37) of the blood donor population. Seroprevalence of toxoplasmosis by age did not reveal any significant difference in our study (p=0.7), even though the highest rates were reported among patients aged between 30 and 45. Contrary to our findings, two previous studies in the same region reported a significant difference (p<0.05) between seropositivity and age among pregnant women (Lo et al. 2012; Tine et al. 2017).

Our seroprevalence is lower than what has been reported in other countries such as Cote d'Ivoire (Siransy et al. 2016), Tunisia (Lachkhem et al. 2020), Egypt (Elsheikha et al. 2009), and Roumania (Lupu et al. 2022). In those countries, seroprevalence ranges from 44.4% to 67.9%. However, it is higher than the recorded seroprevalence among blood donors in Taiwan, which was 9.3% (Chiang et al. 2012). By demographic characteristics, we didn't find a significant correlation between seropositivity and age or gender. The same trend was observed in Cote d'Ivoire by Siransy *et al.* (Siransy et al. 2016). Though the seroprevalence is higher in males, it is difficult to confirm any relationship between gender and *T. gondii* antibodies prevalence since more than 80% of donors are male. Furthermore, the prevalence was comparable between men and women in Tunisia and Iran (Lachkhem et al. 2020; Mansouri et al. 2017). By age, contrary to our findings, Lupu *et al.* reported a significant increase in seroprevalence in Roumania. (Lupu et al. 2022).

Contact with animals and raw meat consumption is worldwide associated with *T. gondii* infection (Foroutan *et al.* 2021). Several studies have reported a high prevalence of *Toxoplasma gondii* infection among cat-owning populations. For example, a study of blood donors in Taiwan found a seroprevalence of 14.7% among those who owned cats, compared to 8.7% among those who did not (Chiang et al. 2012). Similarly, a study in Iran found a seroprevalence of 64.5% among cat owners compared to 36.7% among non-cat owners, (Mahmoudvand *et al.* 2015). These studies suggest a positive correlation between contact with cats and *Toxoplasma gondii* infection. In our series, this trend was not observed (p = 0.3), although a seroprevalence of 50% was noted among blood donors who reported having contact with cats compared to the rate of 32.5% found in the group without cat contact. Similarly, in Tunisia and Roumania, any positive correlation between *T. gondii* seropositivity and contact with cats was found (Lachkhem et al. 2020; Lupu et al. 2022).

Regarding blood type, several studies have investigated the association between *Toxoplasma gondii* infection and blood group, but the results must be consistent. For instance, a survey conducted in Ivory Coast among blood donors reported a significantly higher seroprevalence of *Toxoplasma gondii* infection among individuals with blood

type O compared to those with blood type A or B ((Siransy et al. 2016). Another study in Tunisia reported a higher seroprevalence of *Toxoplasma gondii* infection among individuals with blood type AB compared to those with blood type O (Lachkhem et al., 2020). In our study, though 50% of the blood donors are O-blood type, a remarkable variation in toxoplasmosis seroprevalence ranging from 20% for the AB-blood type to 48.7% for the B-blood type was noted. The relationship between blood and the toxoplasmosis outcome needs to be further investigated.

Nearly half of the blood donors are military in our series. When comparing the seroprevalence between militaries (28.6%) and civilians (37.2%), any significant difference was noted, suggesting that military status is not a risk factor for toxoplasmosis. However, studies involving larger samples are needed to elucidate this hypothesis. Also, no difference was observed in seropositivity according to marital status in our series. In Tunisia, Lachkhem et al. reported a comparable seroprevalence between married (48.21%) and single (41.19%) (Lachkhem et al. 2020).

The limitation of this study was the lack of available data on toxoplasmosis in the general population in Senegal to compare with the seroprevalence in blood donors.

CONCLUSION

This first study on toxoplasmosis among Senegalese blood donors shows a comparable seroprevalence to those reported previously in pregnant women. Any seropositivity regarding *T. gondii* IgM antibodies was noted, suggesting no active toxoplasmosis infection among the blood donors in this study. Although the risk of transfusion-transmitted toxoplasmosis still exists due to its relatively high prevalence, screening *T. gondii* in blood donations in Senegal may not be mandatory.

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Conflicts of Interest

The authors declare that they have no competing interests.

Data Availability

The data used for this research article are available from the corresponding author upon request.

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