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Original Article

Prevalence of anti-*Toxoplasma gondii* antibodies in serum from donors from the blood center in Mato Grosso

Prevalência de anticorpos anti-Toxoplasma gondii em soro de doadores do hemocentro do Mato Grosso
Prevalencia de anticuerpos anti-Toxoplasma gondii en suero de donantes del centro de sangre de Mato Grosso

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ABSTRACT

Background and Objectives: Toxoplasmosis is one of the most prevalent parasitic diseases in Brazil and occurs in healthy individuals with few or no symptoms. The aim of this study was to determine the prevalence of IgG and IgM antibodies to *T. gondii* in the serum of blood donors from Cuiabá, Mato Grosso. **Methods**: This was an observational cross-sectional study with 633 serum samples from blood donors at the Cuiabá Blood Center. A total of 633 serum samples from blood donors were obtained to investigate the prevalence of anti-*T. gondii* antibodies in Cuiabá, Mato Grosso. **Results**: The seroprevalence of *T. gondii* infection was 323/633 (51%). A total of 314/633 (49%) samples were seroreactive for IgG for T. gondii antibodies and nine (1.4%) samples with inconclusive results. In addition, 10/633 (1.57%) samples with IgM for *T. gondii* and 11 (0.1%) samples were inconclusive. Statistical analyses revealed significant differences for the presence of IgG for *T. gondii* in the stratifications by age, adults between 20-60 years of age, (p=0.000) and brown skin color (p=0.002). While for the presence of IgM for *T. gondii*, the variable geographic region of Cuiabá south (p=0.030) was also statistically significant. **Conclusion:** Based on the data obtained, it is inferred a relatively high prevalence of individuals with positive IgG antibodies for *T. gondii* in the blood samples of the tested donors, suggesting a chronic or past infection.

Keywords: *Toxoplasmosis. Serology. Blood Center.*

RESUMO

Justificativa e Objetivos: A toxoplasmose é uma das doenças parasitárias mais prevalentes no Brasil e em indivíduos saudáveis com pouco ou nenhum sintoma. O estudo teve como objetivo realizar a prevalência de anticorpos IgG e IgM para *Toxoplasma gondii* no soro de doadores de sangue de Cuiabá, Mato Grosso. **Métodos:** Estudo transversal observacional com 633 amostras de biorrepositório de soro provenientes de doadores de sangue do Hemocentro de Cuiabá. Um total de 633 amostras de soro de indivíduos doadores de sangue foi obtido para a pesquisa de prevalência de anticorpos anti-*T. gondii* em Cuiabá. **Resultados:** A soroprevalência da infecção por *T. gondii* foi de 323/633 (51%). Foram detectadas 314/633 (49%) amostras sororeativas para anticorpos IgG para *T. gondii* e nove (1,4%) amostras com resultados inconclusivos. Por fim, foram detectadas 10/633 (1,5%) amostras com IgM para *T. gondii* com 11 (0,1%) amostras inconclusivas. As análises estatísticas revelaram diferenças significativas para a presença de IgG para *T. gondii* nas estratificações por idade – adultos entre 20-60 anos de idade (p-valor <0,001) – e cor de pele parda (p-valor 0,002), ao passo que, para a presença de IgM para *T. gondii,* a variável região geográfica sul (p-valor 0,030) mostrou-se também estatisticamente significativa**. Conclusão:** Infere-se prevalência relativamente alta de indivíduos com anticorpos anti-IgG positivo para *T. gondii* nas amostras sanguíneas dos doadores testados, sugerindo uma infecção crônica ou passada.

Descritores: *Toxoplasmose. Sorologia. Hemocentro.*

RESUMEN

Justificación y Objetivos: La toxoplasmosis es una de las enfermedades parasitarias más prevalentes en Brasil y se presenta en individuos sanos con poco o ningún síntoma. El objetivo de este estudio fue determinar la prevalencia de anticuerpos IgG e IgM para *T. gondii* en el suero de donantes de sangre de Cuiabá, Mato Grosso (Brasil). **Métodos:** Este fue un estudio observacional transversal con 633 muestras de biobanco de suero de donantes de sangre en el Centro de Sangre de Cuiabá. Se obtuvo un total de 633 muestras de suero de donantes de sangre para analizar la prevalencia de anticuerpos anti-*T. gondii* en Cuiabá. **Resultados**: La seroprevalencia de la infección por *T. gondii* fue de 323/633 (51%). Un total de 314/633 (49%) muestras fueron serorreactivas para anticuerpos IgG para *T. gondii*, y nueve (1,4%) muestras tuvieron resultados no concluyentes. Además, se detectaron 10/633 (1,57%) muestras con IgM para *T. gondii* y 11 (0,1%) muestras con resultados no concluyentes. Los análisis estadísticos revelaron diferencias significativas en la presencia de IgG para *T. gondii* en las estratificaciones por edad, adultos entre 20 y 60 años (p-valor <0,001) y color de piel parda (p-valor 0,002), mientras que para la presencia de IgM para *T. gondii*, la región geográfica sur (p-valor 0,030) también fue estadísticamente significativa. **Conclusión**: Se infiere una prevalencia relativamente alta de individuos con anticuerpos anti-IgG positivos para *T. gondii* en las muestras de sangre de los donantes analizados, lo que sugiere una infección crónica o previa.

Palabras Clave: *Toxoplasmosis. Serología. Centro de Sangre.*

INTRODUCTION

One-third of the human population is estimated to be infected with the *Toxoplasma gondii,* this parasitosis is the most prevalent in humans.[1] Based on recent epidemiological data, the prevalence of positive serology (IgG) for toxoplasmosis in the world population is estimated around 31%, which corresponds to about one to two billion people.[2]

There is a consensus that about 500 million people worldwide have a positive serological reaction to the parasite.[2] In Brazil, seroprevalence varies from 40% to 80%.[3] Despite being a common infection among humans, the clinical disease in immunocompetent people is rare and restricted to risk groups.[4]

Since the 70s, the transmission of the *T. gondii* Blood transfusions has been a recurring concern, especially after it was shown that the parasite can survive in refrigerated blood.[5] In 1971, the first case of transmission of this parasite occurred by the transfusion of a blood component into a leukocyte concentrate.[6]

Despite monitoring for other infectious agents in donated blood bags, transfusion transmission of the infection by *T. gondii* poses a potential risk to immunocompromised patients receiving these transfusions.[6,7] Blood donors who present seroreactivity to the parasite can be asymptomatic, healthy individuals and be in a phase of rapid multiplication of the parasite, thus being responsible for transfusion transmission.[8,9]

Studies show that the transmission of parasites occurs by transfusions of leukocytes and platelets. Moreover, there is evidence that shows that the parasite can survive in temperatures of up to 5 °C for more than 50 days. Thus, cooling the samples is not effective in preventing transmission.[1,9]

According to a systematic review addressing 38 studies representing 19,691 blood donors from 1998 to 2025, a global average prevalence of anti-*T. gondii* antibodies was detected in 35.7% of donors[10]. In another review, Brazil was considered the country with the highest seroprevalence of *T. gondii* in blood donors.[9]

The risk of transmission of infectious agents increases according to the increase in the frequency of infections in the population. Thus, it is necessary, in each region of the country, to know the main risk factors for each infectious agent to which the population is exposed.[11]

In view of the above, this study aims to assess the seroprevalence of anti-*T. gondii* antibodies in blood donors at the Cuiabá Blood Center, in the state of Mato Grosso.

METHODS

Design

This is a cross-sectional and observational study, conducted with serum samples from blood donors at the MT-Hemocentro de Cuiabá, from a 2025 biorepository, with samples collected between November 2022 and February 2023.[12]

Context and selection criteria

According to the published article,[12] the sample size was calculated using the equation n=[Np(1-p)]/[(d2/Z21/2*(N-1)+p*(1-p)] (OpenEpi v.3)[13], in which n: desired sample size; N: total population size (finite population); p: expected proportion (prevalence or incidence) of the event in the population; 1-p: the complementary proportion; d: margin of error (tolerable absolute error, e.g.: 0.05 for 5%); Z: Z-value (Z-score) corresponding to the desired confidence level, with a 95% confidence range. An estimated prevalence of anti-*T. gondii* antibodies of 50% was presumed in the population of Mato Grosso. Based on the total number of blood donors at the MT-Hemocenter in 2021 (13,512), a sample of 633 blood donors was calculated as statistically representative.

Blood donor sera used in the 2025 study were included in this sample.[12] Samples with improper technical qualities (hemolyzed, low volume, or contaminated) or with a lack of identification information were excluded from the study.

Measurement

The detection of IgG and IgM antibodies to *T. gondii* in the serum samples was performed using the chemiluminescence technique and with the Abbott and Roche Kits, following the manufacturer's recommendations, in which the samples from donors seroreactive for IgG (late infection) and seroreactive for IgM (active infection) were analyzed (Table 1).

The variables available for the analysis of toxoplasmosis, acquired via an epidemiological questionnaire applied in the published article, were: age (young 16–19 years; adult: 20–60 years; older adults: >60 years), according to the age classification in Brazil by the IBGE and adapted to the blood donors of this blood center, sex (male; female), skin color (White, Brown/Mixed-race, Black, Yellow/Asian, and Red/Indigenous), geographic region of residence in Cuiabá (east, west, north, and south), according to the Department of Urban Development of the City of Cuiabá, and the presence of chronic diseases such as diabetes, hypertension and neoplasms (Figures 1 and 2).[12, 14-16]

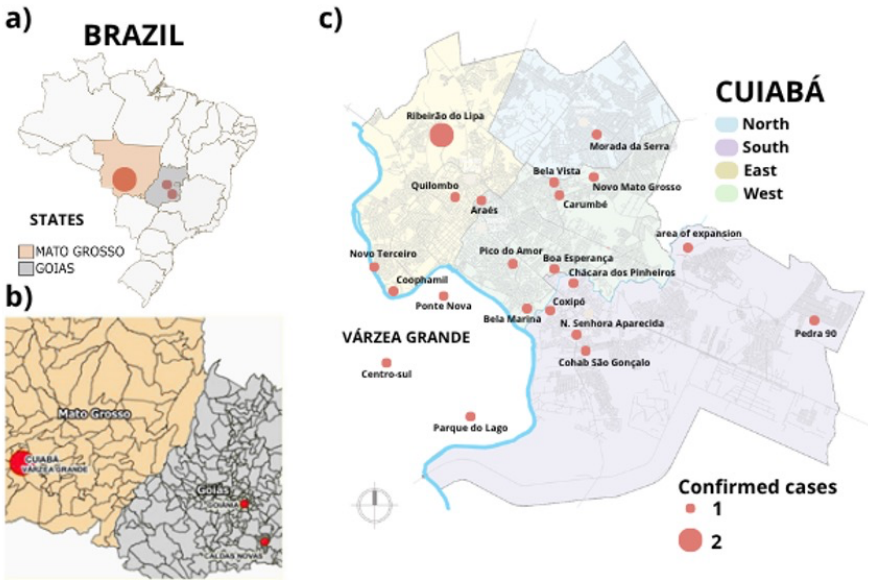

Figure 1. A – Geographical location of the state of Mato Grosso in Brazil. B – Geographic location of the municipality of Cuiabá and other municipalities in which positive serology for IgG and IgM were detected for T. gondii. C – Geographic regions of the municipality of Cuiabá (east, west, north, and south) and the location of seropositive samples for IgG and IgM for T. gondii of blood donors 2022-2023.

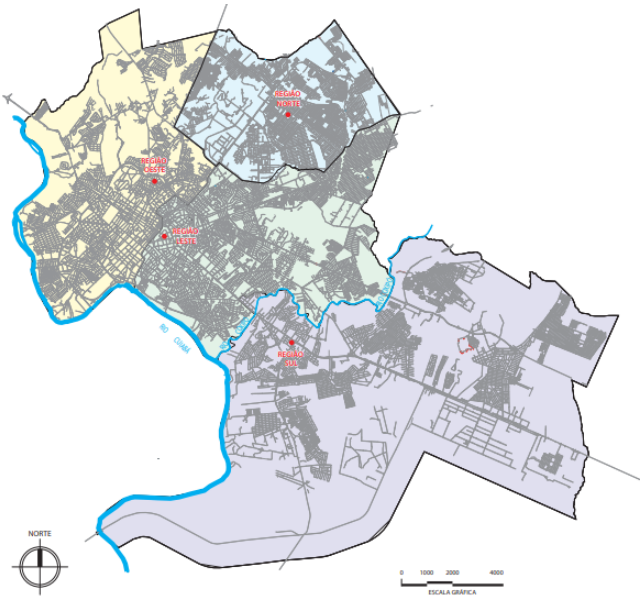

Figure 2. Geographical location of the administrative regions of the municipality of Cuiabá.

Data analysis

Epidemiological data were described using descriptive statistics. Continuous variables such as age groups were expressed according to standard deviation and compared using the t-test of two samples with equal variances. Categorized variables (gender, skin color, geographic region, and chronic disease) were shown in the form of numbers (percentages) and analyzed using Pearson's Chi-square test. Statistically significant values were those with p-values <0.050.

Ethical aspects

This study was approved by the Human Research Ethics Committee of the Faculty of Medicine of the Federal University of Mato Grosso (under CAEE number 54377421.8.0000.8124 and approval 5.291.983), with authorization of the informed consent form and in accordance with Resolution 460/2012 of the Ministry of Health.

RESULTS

The seroprevalence of *T. gondii* infection was 324/633 (51%). A total of 314 out of 633 (49%) samples tested positive for IgG antibodies to *T. gondii*, and nine (1.4%) samples yielded inconclusive results. Finally, 10 out of 633 (1.5%) samples tested positive for IgM antibodies to *T. gondii*, with 11 (0.1%) samples yielding inconclusive results.

Regarding the age group, adults were the most representative with 568/633 (89.7%), thus showing an IgG frequency for *T. gondii* 295/314 (93%) and for IgM for *T. gondii* 10/10 (100%). Regarding gender, most were men, with 171/314 (49%) seropositivity for IgG, and women, with a higher frequency of IgM 6/10 (60%). Regarding skin color, Brown people had a higher frequency of being seropositive for IgG 114/314

(49%), and Brown and White, with the same percentage for IgM 3/10 (37%) (Table 1).

Table 1. Analysis of risk variables among blood donors at the Cuiabá blood center, with serological results of IgG and IgM for T. gondii. 2022-2023 (n=633).

Parameter		Seroreactive IgG				Seroreactive IgM			
		Negative sample N=310	Positive sample N=314	Inconclusive sample N=9	*p*-value	Negative sample N=612	Positive sample N=10	Inconclusive sample N=10	*p*-value
Age	Mean (SD)	30.4 (11)	38.3 (11)	24 (7.5)	<0.001[b]	34 (11)	41.4 (11)	37.8 (8.3)	<0.050[b]
Age group[c], n (%)	Young	35 (11)	6 (2)	5 (55)	**<0.001[a]**	46 (7.5)	0	0	0.647[a]
	Adult	269 (86)	295 (94)	4 (44)		547 (89)	10 (100)	11 (100)	
	Older adult	6 (2)	13 (4.1)	0		19 (3.1)	0	0	
Sex, n (%)	male	168 (48)	171 (49)	6 (1.7)	0.760[a]	334 (96)	4 (40)	7 (2)	0.543[a]
	female	142 (49)	143 (49)	3 (1)		278 (96)	6 (60)	4 (1.4)	
Self-declared Skin color, n (%)	Brown	123 (49)	114 (49)	1 (14)	**0.002[a]**	233 (49)	3 (37)	2 (25)	0.856[a]
	White	94 (37)	61 (26)	4 (57)		151 (32)	3 (37)	5 (62)	
	Black	28 (11)	55 (23)	2 (28)		82 (17)	2 (25)	1 (12)	
	Asian	3 (1.2)	0	0		3 (0.6)	0	0	
	Indigenous	0	2 (0.9)	0		2 (0.4)	0	0	
Geographic region of Cuiabá, n (%)	North	41 (13)	34 (10)	2 (22)	0.085[a]	76 (12)	1 (10)	0	**0.030[a]**
	South	49 (15)	66 (21)	0		110 (18)	3 (30)	2 (18)	
	East	84 (27)	66 (21)	4 (44)		148 (24)	2 (20)	4 (36)	
	West	66 (21)	59 (19)	0		122 (19)	0	3 (27)	
	Várzea Grande	60 (19)	69 (22)	3 (33)		129 (21)	1 (10)	2 (18)	
	Others	10 (3.2)	20 (6.4)	0		27 (4.4)	3 (30)	0	
Chronic disease, n (%)	yes	41 (13)	52 (16.6)	0	0.228[a]	90 (14)	2 (20)	1 (9.1)	0.779[a]
	no	269 (86)	262 (83)	9 (100)		522 (85)	8 (80)	10 (91)	

Abbreviation: n: number; %: percentage; a: Pearson's chi-square test; b: t-test of two samples with equal variances; c:young: 16-19 years old; adult: 20-60 years; older adults >60 years; SD: standard deviation.

Regarding geographic location, 154/633 (24%) live in the eastern region of the municipality. Donors with reactive IgG were mainly concentrated in the eastern (66/314; 21%) and southern (66/314; 21%) regions. Seropositive samples for IgM were identified more in the southern region (3%) of Cuiabá.

Statistical analyses revealed significant differences for the presence of IgG for *T. gondii* in the stratification by age—adults between 20 and 60 years of age (p <0.001)—and among Brown individuals (p=0.002), whereas for the presence of IgM antibodies to *T. gondii*, significantly high prevalence rates were observed in the southern region of Cuiabá (p=0.030).

DISCUSSION

This study found a seroprevalence of 51% of the infection by *T. gondii* in blood donors in the metropolitan region of Cuiabá, 314/633 (49%) of seroreactive samples for IgG antibodies to *T. gondii*, and 10/633 (1.5%) samples with IgM for *T. gondii*.

This infection rate was higher than in some countries, such as Romania and Iran, and even higher than the global average prevalence of *T. gondii* among blood donors, which is currently 35.7%.[17,18] According to this review, when the prevalence of the different types of antibodies is specified, the estimate was 32% for IgG antibodies and 0.8% for IgM.[10]

The prevalence of IgG antibodies identified in this study was higher in studies conducted in different regions of Brazil, where the prevalence ranged from 42.5% to 48% for IgG and within the mean of 0.6% to 2.1% for IgM.[19-21, 32]

Nevertheless, the results of this study are lower than those found in blood donors in the city of Recife (PE), who identified 75% of IgG reagent samples for *T. gondii*.

There were few publications in Brazil between 2000 and 2025 with samples from blood donors. Thus, the publication of data from unevaluated sites becomes essential both for future local interventions and to add to the general averages and better understand the global parasite load.[19-21,32]

Among the results, there were samples with inconclusive results, with 1.4% of samples analyzed for IgG and 0.1% of samples analyzed for IgM. This may indicate that the samples were not characterized within the reference margins of seropositive and seronegative. These results may occur in individuals with recent infections, in which there was no adequate production of antibodies capable of being detected by the tests or the presence of antibodies from other diseases (Table 1).

The variables age and skin color were considered statistically significant for the presence of IgG antibody positivity for *T. gondii* in the population studied, while the variable geographic location of Cuiabá was significant for the presence of IgM antibodies to *T. gondii*. Several authors state that the seroprevalence of toxoplasmosis increases with age, preferably above 40 years of age, possibly due to a longer lifetime exposure in environments and foods contaminated with sporulated oocysts or cysts with bradyzoites. [20,22,23]

Regarding the gender variable, the results of this study were like those of other authors who found a higher prevalence of IgG for *T. gondii* in men (79%) than in women (63%), but with no statistical difference, possibly due to greater exposure to the parasite, due to work activities.[22]

In this study, for the detection of IgM, a greater presence of these antibodies was found in women. This can also occur due to greater frequency in food

preparation and thus greater probability of ingesting raw or undercooked meat containing bradyzoite cysts or even vegetables contaminated with oocysts at the time of trying the food.[32] However, in another study, when analyzing the frequency of IgM+/IgG+ among donor samples, they found a higher frequency in men than in women.[22]

The prevalence of IgG seropositive for *T. gondii* and Brown skin color was also statistically significant. According to the Brazilian Institute of Geography and Statistics (IBGE), in 2022 the Brown population of Cuiabá and regions represented 52%, being considered the majority.[24] Other authors also describe the Brown population as being the one with the highest seroprevalence for IgG antibodies to *T. gondii.*[25-27] This relationship between toxoplasmosis and skin color may have socioeconomic and educational involvements, as they are considered a vulnerable population, according to the Ministry of Health, and live in places with poor basic sanitation and less access to quality education.[28]

In this study, the presence of IgM was also higher than the global mean of 0.8%, but lower than that recorded in Santa Maria (in the state of Rio Grande do Sul), where 8/364 (2.1%) of IgM antibodies were detected in blood bags.[32] The variable geographic location of Cuiabá in the southern region was statistically significant in the prevalence of IgM antibodies to *T. gondii.*

Studying the frequency of IgG and IgM antibodies in serum samples from blood donors helps to understand the risks of parasite transmission via blood transfusion, since the presence of IgM to *T. gondii* it has a strong correlation with the parasitemia of the disease.[19,29] According to the Ministry of Health, serological tests for the detection of antibodies to *T. gondii* are not mandatory for blood donors in Brazil, however studies show that infection by parasites through blood transfusion can occur and that the *T. gondii* survives in citrate blood at 5 °C for more than 50 days, so refrigeration of blood bags during storage does not prevent the transmission of infection.[29-31]

According to studies the concentration of IgG antibodies to *T. gondii* in serum is not correlated with the molecular detection of parasite deoxyribonucleic acid (DNA) in peripheral blood of asymptomatic blood donors, since, even at low or high levels of IgG in serum, no parasite DNA was detected in nested PCR.[19]

Hemotherapy services should educate donors and transfusion recipients about the risks of toxoplasmosis, including, during the clinical screening of candidates for blood donation, specific questions about risk factors for toxoplasmosis and information that serology for this parasite should be done in blood donors, at least when the components are intended for immunosuppressed patients.[33]

Regardless of the results of this research—specifically the presence of serum samples with IgM antibodies to *T. gondii*, representing the acute phase of the disease and the possibility of transmission of the parasite to the recipients of blood bags—some limitations should be considered in order to avoid this type of transmission. First: despite the non-mandatory screening for anti-antibiotic antibodies *T. gondii* in blood centers in Brazil, the screening of the parasite's antibodies among donors would result in many discarded blood bags, considering the high prevalence of antibodies (IgG mainly) of the parasite in the general population. And second: the presence of IgM for *T. gondii* in serological tests does not confirm the presence of the parasite (takyzoites) in blood bags, requiring other more sensitive tests.

We suggest for studies to further investigate the risks and probabilities of transmission of toxoplasmosis via blood transfusion, associating serology and molecular biology techniques to define possible control and prevention measures for transfusion toxoplasmosis.

Thus, the seroprevalence of IgG antibodies for *T. gondii* reflects previous or past exposure to the parasite, which is important for the interpretation of prevalence rates in various regions of the country; this study found a seroprevalence considered high in relation to the global average. Moreover, 1.8% of IgM antibodies were detected, which indicates an acute infection with parasites still present in bloodstream, enabling the transmission via blood transfusion.

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AUTHORS' CONTRIBUTIONS

Michelle Igarashi Watanabe contributed to the bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation and description of the results, preparation of tables, conclusions, review, and statistics. **Victoria Marina Balbinot dos Anjos** contributed to project management, bibliographic research, abstract writing, introduction, methodology, discussion, interpretation and description of results, conclusions, review, and statistics. **Leonardo Marin** contributed to the writing of the abstract, methodology, interpretation of results, conclusions, review, and statistics. **Eduarda Pavan** contributed to the interpretation of the results, conclusions, review, and statistics. **João Luis Garcia** contributed to the acquisition of funds.

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