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# TOXOPLASMA GONDII INFECTION AND ASSOCIATED FACTORS IN BLOOD DONORS FROM HOSPITAL II-2 TARAPOTO, PERU, JULY TO DECEMBER 2019

INFECCIÓN POR TOXOPLASMA GONDII Y FACTORES ASOCIADOS EN DONANTES DE SANGRE DE UN HOSPITAL DE LA SELVA PERUANA

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## ABSTRACT

**Introduction:** Toxoplasmosis is a worldwide parasitic infection caused by *Toxoplasma gondii* that can be transmitted through blood transfusions. **Objectives:** To determine the Rate and associated factors of *T. gondii* infection in blood donors from Hospital II-2 Tarapoto, Peru, July to December 2019. **Methods:** Analytical cross-sectional study carried out in a sample of 92 donors. Infection was determined by detecting serum IgM and IgG anti *T. gondii* antibodies by the Elisa technique. Sociodemographic, environmental and habit factors were collected by applying an interview to each volunteer participant. **Results:** The donor sample was characterized by a median age of 30 years, male gender (76.1%), urban home area (81.5%) and student occupation (34.8%); likewise, 29.4% stated that they ingested non-potable water and 61.9% had contact with earth or sand. 77.2% (95% CI: 68.6 - 85.8) of donors had past infection. No cases of active infection were observed. Contact with cats and domestic animals was associated with infection by *T. gondii* ( $p = 0.037$ ;  $PR = 1.28$  and  $95\% CI = 1.02 - 1.61$ ). **Conclusions:** Blood donors from Hospital II-2 Tarapoto presented a high frequency of chronic infection by *T. gondii*. The possible transmission of the parasite through blood transfusion is suggested, for which reason it is recommended to assess the inclusion of toxoplasmosis as a screening test.

**Key words:** Toxoplasma; Blood donors; Blood Transfusion; Risk factors (source: MeSH NLM).

## RESUMEN

**Introducción:** La toxoplasmosis es una infección parasitaria de distribución mundial causada por *Toxoplasma gondii* transmisible mediante transfusiones sanguíneas. **Ojetivos:** Determinar la frecuencia y los factores asociados de la infección por *T. gondii* en donantes de sangre del Hospital II-2 Tarapoto, Perú, julio a diciembre del 2019. **Métodos:** Estudio transversal analítico realizado en una muestra de 92 donantes. La infección se determinó mediante la detección anticuerpos séricos IgM e IgG anti *T. gondii* por la técnica de Elisa. Los factores sociodemográficos, ambientales y hábitos se recolectaron mediante la aplicación de una entrevista. **Resultados:** La muestra de donantes se caracterizó por una mediana de edad fue de 30 años, género masculino (76,1 %), zona domiciliaria urbana (81,5 %) y ocupación estudiante (34,8 %); asimismo el 29,4 % manifestó ingerir agua no potable y el 61,9% tener contacto con tierra o arena. El 77,2% (IC95 %: 68,6 - 85,8) de donantes presentaron infección pasada. No se observó casos de infección activa. El contacto con gatos y animales domésticos estuvo asociado con la infección por *T. gondii* ( $p=0,037$ ;  $RP=1,28$  e  $IC95 \%=1,02 - 1,61$ ). **Conclusión:** Donantes de sangre del Hospital II-2 Tarapoto presentaron alta frecuencia de infección crónica por *T. gondii*. Se sugiere la posible transmisión del parásito mediante transfusión sanguínea, por lo que recomienda valorar la inclusión de la toxoplasmosis como prueba de tamizaje.

**Palabras clave:** Toxoplasma; Donantes de Sangre; Transfusión sanguínea; Factores predisponentes (fuente: DeCS BIREME).

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## INTRODUCTION

Toxoplasmosis is an infectious disease caused by the protozoic parasite *Toxoplasma gondii*, and it affects the majority of warm blooded animals, including humans. Considered a reemerging and cosmopolitan zoonosis, whose definitive hosts are cats and other felines<sup>(1,2)</sup>. Human infection is frequent and is mainly transmitted through the intake of raw or undercooked animals and contaminated water, transplacentally from mother to fetus, and through blood transfusion or transplants<sup>(2-4)</sup>.

Infection in immunocompromised people is subclinical or with mild and self-limited clinical manifestations, however the parasite may “hide” and remain inactive for years and reactivate when the immunological system is affected<sup>(4,5)</sup>; leading not only to an active disease but the possibility of a hematogenous transmission. Primary infection in pregnant women is the most important and may produce fetal death, neurological and ocular lesions, and disabling consequences<sup>(6-10)</sup>. While the infection represents high morbidity and mortality in immunocompromised people<sup>(5,11-13)</sup>. Likewise, recent studies have linked toxoplasmosis with Schizophrenia<sup>(14)</sup>.

Exposure of *T. gondii* in blood donors around the world is 33 %. Brazil, a bordering country to Peru and with similar climate and environmental characteristics, is where the highest seroprevalence in donors has been reported at 75%<sup>(15)</sup>. While, in Peru, the only report was in a hospital in Pasco, where 83.9% rate of IgG anti *T. gondii* antibodies were found<sup>(16)</sup>. We should consider that each year there are hundreds of thousands of blood transfusions in a medical practice each time more common in Peru and worldwide.

It should be noted that, in Peru, the screening tests for infectious diseases in blood transfusions do not include *T. gondii*. Furthermore, the prevalence and associated factors (sociodemographic, environmental and habits) of *T. gondii* infection in the study population are unknown<sup>(3,15,17)</sup>. For this reason, the current study’s objective was to determine the rate and associated factors of *Toxoplasma gondii* infection in donors of the Hospital II-2 Tarapoto, Peru, July to December 2019.

## METHODS

### Design and study area

Observational, cross-sectional, analytical and prospective study. The study was performed in the geographic space of the northeastern region of Peru, department of San Martin. This region is 350 MASL, with an approximate population of 180,073 inhabitants, presents a tropical climate and is mainly rural. Hospital II-2 of Tarapoto, the most important city of the region, is the major complex hospital in the region.

### Population and sample

The population consists of approximately 1200 donors of the Blood Bank Service of Hospital II-2 of Tarapoto during the months of July to December of 2019. We studied a sample of 92 donors, a size obtained through the informatic software online: Working in Epidemiology to assess the proportion when the population is known. For these purposes, we took into account a 95% confidence Interval, 8% error and an 83.6% expected prevalence, according to reference<sup>(16)</sup>. This was a simple random sampling.

We excluded donors who could not read, understand or who declined to sign the informed consent.

### Variables and instruments

*T. gondii* infection was measured through serologic tests that were standardized using Enzyme Linked Immunosorbent Assay ELISA, following the manufacturer’s recommendations (Vircell ®). The IgM antibodies were evaluated qualitatively (Kit *Toxoplasma* Elisa IgM capture-Vircell ®), IgG (Kit *Toxoplasma* Elisa IgG capture-Vircell ®) against *T. gondii*. The positive interpretation, according to the kit, would be the index values greater than 11, in both assessments.

The disease detection diagnostic kits used showed inserted written information that validated its purpose. The sensitivity and specificity described for the kits were 100% and 97% for IgM and 98% and 100% for IgG, respectively. A second sample was requested after 15 to 21 days for the donors whose samples resulted only positive to IgM or IgG, to evaluate seroconversion (from IgM to IgG) or titer increments of IgG.

Acute toxoplasmosis (active infection) was diagnosed when sample results were positive to IgM and IgG, or when there was evidence of seroconversion from IgM to IgG or IgG titer increase of more than four-fold in the second sample. While chronic toxoplasmosis was diagnosed when samples were positive only to IgM or IgG and no seroconversion or titer increase

was evidenced in the second sample of IgM and IgG, respectively.

On the other hand, the sociodemographic factors were measured through an interview guide. This document was first evaluated by experts in Infectology and Microbiology and contained questions regarding sociodemographic, environmental, and dietary habit variables.

### Procedures

Participants were enrolled during the donor evaluation at the blood bank in the hospital, where they signed the informed consent. The collection of sociodemographic factors was performed through an interview process for each participant. Afterwards, a venous blood sample was taken, where infection was detected through serum IgM and IgG anti *Toxoplasma gondii* antibodies.

### Statistical analysis

The collected data was organized in a Microsoft Excel 2013 data base. Afterwards, the data was analyzed with a Stata vs 11.1 statistical program and according to the nature of each variable. A descriptive analysis of the qualitative variables was performed through absolute and relative rates, and confidence intervals of 95% (CI 95%). Quantitative variables were presented as measures of central tendency and dispersion generating tables for its analysis, with a preliminary Kolmogorov-Smirnov Goodness of Fit test.

The bivariate analysis of association of toxoplasmosis and factors were performed through Pearson's chi-squared test or Fisher's exact test and a significance level of  $p < 0,05$ . The measure of associations between factors and the greater rate of *T. gondii* infection were presented as prevalence ratio (PR) with a confidence interval of 95%.

### Ethical consideration

We obtained the institutional consent of the blood

bank of the Hospital II-2 of Tarapoto to carry out this study. Furthermore, we requested the protocol revision and approval by the institutional and independent ethics committee of the Hospital Regional Lambayeque. We also guaranteed, at all times, the fulfillment of criteria of autonomy and anonymity of each participant, as well as the voluntary participation in the study after reading, understanding and signing the written informed consent.

## RESULTS

We studied 92 donors in the Hospital II Tarapoto, September through December of 2019. Median age was 30 years, interquartile range was 22 to 36 years.

77,2% (CI95 %: 68,6% - 85,8%) of donors presented IgG anti *T. gondii*, corresponding to chronic infection or past exposure. No donors with presence of IgM anti *T. gondii* were observed. No cases of acute infection by *T. gondii* were observed.

The donor sample in the study period was characterized predominantly by the masculine gender (76,1%), origin from the San Martin region (90,2 %), urban residential zone (81,5 %) and student as their occupation (34,8 %). (See table 1).

With respect to the environmental and habit aspects, the sample was characterized predominantly by no contact with cats, dogs, domestic or wild animals, with 66,3%, 60,9%, respectively. Likewise, 29,4% ingested non-potable water and 61,9% referred having contact with soil or sand (See table 2).

In the bivariate analysis, we observed that none of the evaluated sociodemographic variables presented an association with infection by *T. gondii* (See table 1). However, we observed that in the environmental factors, contact with cats and domestic animals presented an association with infection by *T. gondii*, both with values of  $p=0,037$ ;  $RP=1,28$  and  $CI95\%=1,02 - 1,61$  (See table 2).



**Table 1.** Sociodemographic factors associated to infection by *T. gondii* in blood donors from Hospital II-2 Tarapoto, Peru, July to December 2019.

| Sociodemographic characteristics | N (%)     | <i>T. gondii</i> / total (%) | p - Value |
|----------------------------------|-----------|------------------------------|-----------|
| <b>Age (years)</b>               |           |                              |           |
| 18 to 29                         | 44 (47.8) | 31/44(70.5)                  | 0.213*    |
| 30 to 59                         | 48 (52.2) | 40/48(83.3)                  |           |
| <b>Sex</b>                       |           |                              |           |
| Femenine                         | 22 (23.9) | 18/22(81.8)                  | 0.584*    |
| Masculine                        | 70 (76.1) | 53/70(75.7)                  |           |
| <b>Origin</b>                    |           |                              |           |
| San Martín                       | 83 (90.2) | 65/83(78.3)                  | 0.678*    |
| Others                           | 9 (9.8)   | 6/9(66.7)                    |           |
| <b>Residential zone</b>          |           |                              |           |
| Rural                            | 17 (18.5) | 15/17(88.2)                  | 0.341*    |
| Urbano                           | 75 (81.5) | 56/75(74.7)                  |           |
| <b>Occupation</b>                |           |                              |           |
| Agriculture-laborer              | 19 (20.6) | 12/19(63.2)                  | 0.641**   |
| Home                             | 9 (9.8)   | 8/9(88.9)                    |           |
| Merchant                         | 19 (20.6) | 16/19(84.2)                  |           |
| Student                          | 32 (34.8) | 25/32(78.1)                  |           |
| Office                           | 9 (9.8)   | 7/9(77.8)                    |           |
| Health                           | 4 (4.4)   | 3/4(75.0)                    |           |

(\*) p-Value from Fisher's Exact test, (\*\*) p-Value from Chi-squared test.

**Table 2.** Environmental and habit factors associated to infection by *T. gondii* in blood donors from Hospital II-2 Tarapoto, Peru, July to December 2019.

| Environmental and habit characteristics  | N (%)     | <i>T. gondii</i> / total (%) | p-Value* |
|--|-----------|------------------------------|----------|
| <b>Contact with cats</b>                 |           |                              |          |
| Yes                                      | 31 (33.7) | 28/31(90.3)                  | 0.037    |
| No                                       | 61 (66.3) | 43/61(70.5)                  |          |
| <b>Contact with dogs</b>                 |           |                              |          |
| Yes                                      | 36 (39.1) | 30/36(83.3)                  | 0.315    |
| No                                       | 56 (60.9) | 41/56(73.2)                  |          |
| <b>Contact with domestic animals</b>     |           |                              |          |
| Yes                                      | 31 (33.7) | 28/31(90.3)                  | 0.037    |
| No                                       | 61 (66.3) | 43/61(70.5)                  |          |
| <b>Contact with wild animals</b>         |           |                              |          |
| Yes                                      | 7 (7.6)   | 5/7(71.4)                    | 0.999    |
| No                                       | 85 (92.4) | 66/85(77.6)                  |          |
| <b>Intake of non-potable water</b>       |           |                              |          |
| Yes                                      | 27 (29.4) | 22/27(81.5)                  | 0.596    |
| No                                       | 65 (70.6) | 49/65(75.4)                  |          |
| <b>Intake of raw or undercooked meat</b> |           |                              |          |
| Yes                                      | 9 (9.8)   | 8/9(88.9)                    | 0.459    |
| No                                       | 83 (90.2) | 63/83(75.9)                  |          |
| <b>Intake of raw vegetables</b>          |           |                              |          |
| Yes                                      | 5 (5.4)   | 4/5(80.0)                    | 0.999    |
| No                                       | 87 (94.6) | 67/87(77.0)                  |          |
| <b>Contact with soil or sand</b>         |           |                              |          |
| Yes                                      | 57 (61.9) | 45/57(78.9)                  | 0.618    |
| No                                       | 35 (38.1) | 26/35(74.3)                  |          |

(\*) p-Value from Fisher's exact test

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## DISCUSSION

In the population of this study, the predominantly masculine gender (76,1%) and the median age of 30 years stand out, which describes the type of people that are participating as blood donors, volunteers or replacements. Also, it is a predominantly urban population (81,5%), that however engage in activities with dirt and sand contact (61,9%), drink non-potable water and more than half of them have contact with cats, dogs or domestic or wild animals. These characteristics reveal the multiple possibilities that the population presents to acquire *T. gondii* infection<sup>(3)</sup>, given that these are recognized as risk factors for disease transmission.

In the current study performed with donor sample from a blood bank in the Hospital II Tarapoto, we observed that 77,2 % of donors presented evidence of past infection or chronic *T. gondii* infection, by virtue of seropositivity of IgG anti *T. gondii* antibodies, without seroconversion. These results reveal the high exposure of this study's population to the parasite and, therefore, the existence of multiple risk factors that allow one or more forms of parasite transmission (intake of contaminated food or water, zoonotic, transplacental or transfusion)<sup>(3)</sup>.

When the infection is "past" or chronic, in theory no circulating parasites "exist", however, the risk exists that the infection be transmitted in the large quantities of blood transfused. In addition, despite primary infection not producing serious complications in immunocompromised individuals, the reactivation of the disease in the future, when the immune system is affected by natural or iatrogenic causes, is a real possibility<sup>(2,5,18)</sup>.

The high seropositivity of IgG in blood donor in the Hospital II Tarapoto, Peru, observed in our study (77,2 %), contrasts with that observed in prior studies around the world, also in blood donors, where they found lower rates: 5,8 % in India<sup>(19)</sup>, 29,6%<sup>(20)</sup> and 31,8%<sup>(21)</sup> in Iran, around 7%<sup>(22-24)</sup> in China, and 56,9% in Egypt<sup>(25)</sup>. Likewise, in Latin America, the seropositivity rates vary: 17,4% in El Salvador<sup>(26)</sup>, 29,9 % in Colombia<sup>(27)</sup>, 13,5 % in Mexico<sup>(17)</sup> and from 38,2% to 73,3 % in Cuba<sup>(28-30)</sup>. While in Tingo María, Peru, a region of the central jungle, a high rate similar to that observed in the current study was reported (83,9%)<sup>(16)</sup>. In the same manner, Silva-Díaz et al. evidenced high seroprevalence of toxoplasmosis in pregnant women in Lambayeque (35,8%)<sup>(10)</sup>. The comparison with these studies reveals that the study population presents one of the highest rates of *T. gondii*

exposure and infection.

However, in this study we did not observe donors with primary or acute infection, due to the absence of IgM anti *T. gondii* antibodies or the increase of IgG titers. Considering that the median age of donors was 30 years, with a range of 22 to 36 years, these results indicate that parasite exposure is frequent and primary infection in the study population presents early on. These results concur with a prior study in El Salvador where they also did not observe acute infection in donors<sup>(30)</sup>. Nonetheless, in most prior studies where they search for IgM anti *T. gondii* in donors, rates lower than 5% have been reported, internationally<sup>(19-21)</sup> and in Latin America<sup>(17,30)</sup>.

In relation to associated factors, the presence of IgG anti *T. gondii* antibodies in donors were related to contact with cats and domestic animals. In fact, domestic cats and felines in general, are the definitive hosts of *T. gondii*. They serve as reservoir and multiply the parasite in their intestine and eliminate the oocysts through feces, contaminating the soil, sand and its fur and other spaces they occupy, places where the intermediate hosts, which includes humans, are infected<sup>(1)</sup>. Prior studies have also associated these factors with the presence of infection in donors<sup>(23,31)</sup>.

We did not find an association of age, sex, household zone and occupation to infection. We also did not find an association to contact with dogs, wild animals, intake of non-potable water or intake of meat, raw or undercooked vegetables. Despite that these are fully described as factors related to toxoplasmosis<sup>(3)</sup>, there was no evidence in this study.

In fact, prior studies have associated sex<sup>(20,23)</sup>, intake of processed meat<sup>(25)</sup>, age and tobacco use<sup>(17,23)</sup> and eating grilled/barbecue, sharing cutting board between cooked and raw food, and not having the habit of hand washing before meals<sup>(23)</sup>. These findings can be explained by the different sociodemographic, environmental, and cultural conditions of the studied populations, as well as by the different methodologies of variable measure and analysis, research design used and strength of the studied samples.

Blood transfusion is not the most frequent or important form of toxoplasmosis transmission<sup>(1,3)</sup>, especially if the blood originates from a donor with past infection, meaning seropositive only to IgG. However, latent infection and the disease reactivation shown<sup>(5)</sup> may suggest the presence of



parasite tachyzoites or bradyzoites in donated blood, and, therefore, transmit the disease to the recipient. The infection reactivation in immunocompromised patients are the important cause of current morbidity and mortality<sup>(5,13)</sup>.

The current study presented some limitations. First, the research design, observational, analytical, cross-sectional, did not allow to show cause-effect relationships between the evaluated factors and the presence of *T. gondii* infection. However, other factors studies are widely recognized as toxoplasmosis risk factors. In addition, the results open up new lines of research and serve as background for future complementary studies. Second, the reduced sample size may have affected the statistical estimators to demonstrate an association between the factors studied and toxoplasmosis.

**Authorship contributions:** ADG and HSD participated in the conception and design of the study. ADG performed the data collection. HSD performed the data analysis and interpretation of results. ADG and HSD wrote and approved the final version of the scientific article.

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## CONCLUSION

We conclude that there is a high rate of chronic infection by *T. gondii* in blood donors from Hospital II-2 Tarapoto, Peru, consequently the blood transfusion transmission risk exists. Furthermore, contact with cats and domestic animals were the factors associated to the higher rate of infection. It is recommended to perform complementary studies using direct diagnostic tests of high sensitivity to demonstrate the presence of the parasite in circulating blood and assess the transfusion transmission risk. In addition, it is suggested to evaluate the possibility of including toxoplasmosis in donor screening tests, particularly in disease non-endemic regions and in donors originating from areas with high rates.

**Interest conflict:** The authors declare no conflict of interest.

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