Journal of Zoonotic Diseases
https://jzd.tabrizu.ac.ir/
Published by the University of Tabriz
Online ISSN: 2717-2910

Frequency of anti-*Toxoplasma gondii* IgG antibodies and associated variables among veterinary clinic personnel in Medellín, Colombia

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Article type:
Original Article

Keywords:
Toxoplasmosis
Toxoplasma gondii
Seroepidemiology
Colombia

Article history:
Received:
June 17, 2026
Revised:
July 22, 2026
Accepted:
August 23, 2026
Available online:
August 25, 2026

Abstract

Toxoplasmosis is a globally distributed zoonotic disease of major public health importance. Veterinary clinic personnel may be exposed to the parasite through frequent contact with companion animals, biological materials, and contaminated environments. This exploratory analytical cross-sectional study aimed to determine the frequency of anti-*Toxoplasma gondii* IgG seropositivity and identify factors associated with previous exposure among personnel working in companion-animal veterinary clinics in Medellín, Colombia. Blood samples were collected from 71 participants, and anti-*T. gondii* IgG antibodies were detected using a commercial ELISA kit. Sociodemographic, occupational, behavioral, and epidemiological information was collected using a structured questionnaire. Associations with seropositivity were evaluated using bivariate analysis and multivariate logistic regression. Anti-*T. gondii* IgG antibodies were detected in 22 participants (30.99%). In the multivariate analysis, cat ownership was strongly associated with seropositivity, whereas consistent use of personal protective equipment was associated with significantly lower odds of previous exposure. No other evaluated variables reached statistical significance in the bivariate analysis. Although the wide confidence intervals reflect the limited sample size and the exploratory nature of the analysis, these findings provide the first evidence of previous *T. gondii* exposure among veterinary clinic personnel in Medellín and identify cat ownership and consistent PPE use as variables associated with seropositivity in this population. The results reinforce the importance of strengthening biosafety practices in veterinary clinics and support larger multicenter studies to better characterize occupational risk factors for toxoplasmosis.

Introduction

Toxoplasmosis is a globally distributed zoonotic disease caused by the obligate intracellular protozoan *Toxoplasma gondii*, a parasite belonging to the phylum Apicomplexa and the family Sarcocystidae (1). *T. gondii* infects a broad range of

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https://doi.org/10.22034/jzd.2026.22113
https://jzd.tabrizu.ac.ir/article_22113.html
Cite this article: Rodríguez Vásquez V., Agudelo Camacho J.M., Ocampo Mejía M.C., et al., Frequency of anti-*Toxoplasma gondii* IgG antibodies and associated variables among veterinary clinic personnel in Medellín, Colombia. Journal of Zoonotic Diseases, 2026, 10 (3): 1313-1323.

warm-blooded vertebrates. Domestic and wild felids are the definitive hosts, whereas humans, birds, and numerous domestic and wild mammals serve as intermediate hosts (2). Among felids, domestic cats (*Felis catus*) play a pivotal role in the epidemiology of toxoplasmosis because they shed environmentally resistant oocysts in their feces, contaminating soil, water, and food and thereby facilitating parasite transmission to humans and other animals (3).

In humans, toxoplasmosis is usually asymptomatic or associated with mild clinical manifestations in immunocompetent individuals, after which the parasite establishes a lifelong latent infection. However, in immunocompromised individuals, latent infection may reactivate and lead to severe manifestations, including encephalitis, myocarditis, polymyositis, lymphadenitis, and chorioretinitis (4). In recent years, increasing attention has also focused on the potential association between chronic *T. gondii* infection and several neuropsychiatric disorders, further highlighting the public health relevance of this parasite (5). Serological methods, particularly enzyme-linked immunosorbent assays (ELISA), remain the most widely used approach for detecting previous exposure to *T. gondii*. In contrast, molecular techniques such as polymerase chain reaction (PCR) have improved the diagnosis of active infection and epidemiological surveillance because of their high sensitivity and specificity (6).

In Colombia, the epidemiology of toxoplasmosis has not been fully characterized across different population groups. A comprehensive review by Cañón-Franco et al. reported seroprevalence estimates ranging from 24% to 71.8% in studies conducted between 1944 and 2014 (7). More recently, anti-*T. gondii* IgG seropositivity of 38.5% was reported among blood donors in Cúcuta, providing additional evidence of widespread human exposure (8). Furthermore, *T. gondii* has been detected in meat intended for human consumption, highlighting the circulation of the parasite in the food chain and reinforcing its importance as a foodborne zoonotic pathogen (9).

Several studies have evaluated populations with potential occupational exposure to *T. gondii*. Anti-*T. gondii* antibodies have been detected among veterinary students exposed during their professional training (10), while slaughterhouse workers in Colombia have shown seropositivity rates of up to 71.8% (11). These findings suggest that occupational groups with frequent contact with animals, animal tissues, or contaminated biological materials may be at increased risk of previous exposure to the parasite. Nevertheless, exposure to *T. gondii* is likely influenced by both occupational and non-occupational factors. Occupational exposure may occur through contact with animals, biological samples, or contaminated materials during veterinary practice. In contrast, domestic exposure may result from household contact with cats or environments contaminated with feline feces. Distinguishing these potential exposure pathways is relevant for understanding infection patterns and for designing appropriate preventive strategies. Consequently, toxoplasmosis is recognized as one of the most important zoonotic diseases worldwide because of its impact on human and animal health, as well as its economic and ecological consequences (12). Moreover, the disease represents a clear example of the One Health concept, given the close interaction among humans, domestic animals, wildlife, and the environment in its transmission cycle (13).

Veterinary clinic personnel constitute an occupational group with frequent exposure to companion animals, biological samples, and potentially contaminated environments. Nevertheless, information regarding *T. gondii* exposure and associated factors among veterinary clinic personnel in Colombia remains scarce. Identifying factors associated with previous exposure in this population is essential for strengthening biosafety practices and improving preventive strategies against zoonotic diseases. Therefore, this exploratory analytical cross-

sectional study aimed to determine the frequency of anti-*Toxoplasma gondii* IgG seropositivity and identify factors associated with previous exposure among personnel working in companion-animal veterinary clinics in Medellín, Antioquia, Colombia.

Materials and Methods

Study design, setting, and population

An exploratory analytical cross-sectional study was conducted between May and December 2023 among personnel from seven companion-animal veterinary clinics located in Medellín, Antioquia, Colombia. Veterinary clinics were selected by convenience according to their willingness to participate during the study period. The study population comprised veterinarians, veterinary assistants, veterinary medicine interns, laboratory personnel, administrative staff, and general services personnel who had direct or indirect occupational contact with companion animals.

Eligible participants were adults (≥18 years old) who voluntarily agreed to participate and provided written informed consent. Individuals who declined to participate or whose blood samples were insufficient for serological analysis were excluded.

Epidemiological survey

Each participant completed a structured questionnaire designed by the research team to obtain information on sociodemographic characteristics, occupational activities, behavioral habits, biosafety practices, animal exposure, and epidemiological variables potentially associated with *T. gondii* infection. The questionnaire also included items evaluating participants' knowledge of toxoplasmosis, potential routes of transmission, contact with companion animals, dietary habits, hygiene practices, previous medical history, and occupational exposure during veterinary clinical practice.

Blood sampling and serum processing

Approximately 5 mL of peripheral venous blood was collected from each participant using sterile vacuum collection tubes following standard biosafety procedures. Blood samples were centrifuged at 3,500 rpm for 5 min to obtain serum, which was aliquoted into sterile microtubes and stored at −80 °C until serological analysis.

*Detection of anti-*Toxoplasma gondii *IgG antibodies*

Previous exposure to *T. gondii* was determined by detecting anti-*T. gondii* IgG antibodies using a commercial enzyme-linked immunosorbent assay (TOXO IgG ELISA, Diagnostic Bioprobes, Italy), following the manufacturer's instructions (14). Positive and negative controls supplied with the kit were included in each analytical run to ensure assay validity. Optical density values were measured using an ELISA microplate reader, and serum samples were classified as positive or negative according to the cutoff values established by the manufacturer. The presence of anti-*T. gondii* IgG antibodies was interpreted as evidence of previous exposure to the parasite.

Statistical analysis

Data were entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics summarized the characteristics of the study population. Categorical variables were expressed as absolute frequencies and percentages. Educational level and occupation were reported descriptively. Because several categories contained very small numbers of participants, no inferential comparisons were reported for these variables. Associations between anti-*T. gondii* IgG seropositivity and explanatory variables were initially evaluated using Pearson's chi-square test or Fisher's exact test, as appropriate. Crude odds ratios (ORs) and corresponding 95% confidence intervals (95% CIs) were estimated by bivariate analysis.

Variables with a P value <0.25 in the bivariate analysis were considered candidates for inclusion in a multivariate logistic regression model to identify factors independently associated with seropositivity. Adjusted odds ratios (aORs) with 95% CIs were estimated, and statistical significance was established at P <0.05. Considering the

convenience sampling strategy, the relatively small sample size, and the exploratory nature of the study, the multivariate analysis was performed to identify potential factors associated with previous exposure rather than to establish causal relationships or generate population-level estimates. Therefore, the findings should be interpreted as hypothesis-generating and warrant confirmation in larger multicenter studies.

Results

Anti-*T. gondii* IgG antibodies were detected in 22 of 71 participants evaluated, corresponding to a seropositivity frequency of 30.99%. The sociodemographic and occupational characteristics of the study population are presented in Table 1. Most participants were women (81.7%). Veterinarians represented the largest occupational group, followed by administrative personnel and veterinary assistants. Professional and technical training were the most frequent educational levels among participants.

Table 1. Sociodemographic and occupational characteristics of the study population (n = 71).

Variable		n	%
Sex	Female	58	81.69
	Male	13	18.30
Occupation	Veterinarian	19	26.80
	Administrative staff	16	22.50
	Veterinary assistant	14	19.70
	Veterinary medicine intern	12	16.90
	General services staff	5	7.00
	Laboratory staff	3	4.30
	Canine groomer	2	2.80
Educational level	Professional degree	28	39.40
	Technical training	18	25.40
	High school education	14	19.70
	Postgraduate degree	10	14.10
	Technologist degree	1	1.40

Knowledge and epidemiological characteristics related to toxoplasmosis are summarized in Table 2. Nearly half of the participants reported having only limited knowledge of toxoplasmosis (47.9%), whereas 43.7% considered themselves knowledgeable about the disease. Considerable variability was observed regarding the recognition of the clinical consequences of toxoplasmosis, susceptible populations, and transmission routes. More than half of the participants (54.9%) reported routine occupational contact with both cats and dogs.

The associations between anti-*T. gondii* IgG seropositivity and the evaluated variables are presented in Table 3. In the bivariate analysis, cat ownership was positively associated with seropositivity (crude OR = 4.37; 95% CI: 1.14–16.75; $P = 0.02$), whereas consistent use of personal protective equipment (PPE) during work was associated with lower odds of seropositivity (crude OR = 0.20; 95% CI: 0.06–0.71; $P = 0.01$). No statistically significant associations were observed for sex, dietary habits, occupational activities, history of needle-stick injury, contact with cat feces, or the remaining evaluated variables.

Variables with $P < 0.25$ in the bivariate analysis were included in the exploratory multivariate logistic regression model (Table 4). After adjustment, cat ownership remained the factor most strongly associated with anti-*T. gondii* IgG seropositivity (adjusted OR = 9.41; 95% CI: 1.60–55.23; $P = 0.013$). In contrast, consistent use of PPE during work remained independently associated with reduced odds of previous exposure (adjusted

OR = 0.10; 95% CI: 0.02–0.54; *P* = 0.007). None of the remaining variables included in the model reached statistical significance.

Table 2. Knowledge and epidemiological characteristics related to toxoplasmosis among veterinary clinic personnel (n = 71)

Self-reported knowledge about toxoplasmosis	n	%
Limited knowledge of the disease	34	47.90
Knowledgeable about the disease	31	43.70
No knowledge of the disease	5	7.00
Expert knowledge	1	1.40
Main health problems associated with toxoplasmosis	**n**	**%**
Other combinations of clinical manifestations	19	27.00
Do not know	15	21.10
Abortion	10	14.10
Hydrocephalus/microcephaly, psychomotor or mental delay, abortion, epilepsy, anemia, and ocular disorders	4	5.60
Other responses or combinations	23	32.40
Populations considered most affected by toxoplasmosis	**n**	**%**
Any person	34	47.90
Immunosuppressed individuals	9	12.70
Do not know	8	11.30
Fetuses	4	5.60
Other responses or combinations	16	22.50
Possible routes of parasite transmission	**n**	**%**
Other combinations of transmission routes	14	19.70
Consumption of contaminated meat, poorly washed fruits and vegetables, unsafe water, inadequate hand hygiene after soil contact, and cleaning cat litter boxes	11	15.50
Inadequate hand hygiene after soil contact and cleaning cat litter boxes	8	11.30
Do not know	8	11.30
Cleaning cat litter boxes	5	7.00
Other responses or combinations	25	35.20
Main animals with which participants reported contact	**n**	**%**
Cats and dogs	39	54.90
Cats	7	9.90
Cats, dogs, horses, and birds	4	5.60
Cats, dogs, and birds	4	5.60
Cats, dogs, and horses	3	4.20
Other animal combinations	14	19.80

Participants were allowed to select more than one response for some questions; therefore, percentages may not total 100%.

Table 3. Bivariate analysis of variables associated with anti-*T. gondii* IgG seropositivity among veterinary clinic personnel.

Variable	Category	Positive n (%)	Negative n (%)	P-value*	Crude OR**	95% CI Lower Limit	95% CI Upper Limit
Sex	Female	18 (25.40)	40 (56.30)	0.99	1.01	0.28	3.73
	Male	4 (5.60)	9 (12.70)				
Cat ownership	Yes	19 (26.80)	29 (40.80)	0.02	4.37	1.14	16.75
	No	3 (4.20)	20 (28.20)				
Consistent use of personal protective equipment (PPE) during work	Yes	14 (19.70)	44 (62.00)	0.01	0.20	0.06	0.71
	No	8 (11.30)	5 (7.00)				
Consumption of unwashed or non-disinfected fruits and vegetables during the previous 3 months	Yes	8 (11.30)	24 (33.80)	0.32	0.60	0.21	1.67
	No	14 (19.70)	25 (35.20)				
Consumption of undercooked or rare meat during the previous 3 months	Yes	7 (9.90)	16 (22.50)	0.95	0.96	0.33	2.83
	No	15 (21.10)	33 (46.50)				
Consumption of unpasteurized dairy products during the previous 3 months	Yes	1 (1.41)	7 (9.86)	0.23	0.29	0.03	2.48
	No	21 (29.58)	42 (59.15)				
Consumption of street food during the previous 3 months	Yes	18 (25.35)	45 (63.38)	0.22	0.40	0.09	1.77
	No	4 (5.63)	4 (5.63)				
Consumption of untreated drinking water during the previous 3 months	Yes	7 (9.86)	15 (21.13)	0.92	1.06	0.36	3.13
	No	15 (21.13)	34 (47.89)				
Always washing hands before eating	Yes	14 (19.71)	28 (39.44)	0.46	1.31	0.47	3.70
	No	8 (11.27)	21 (29.57)				
Contact with cats in the workplace	Yes	19 (26.76)	48 (67.61)	0.05	0.13	0.01	1.35
	No	3 (4.23)	1 (1.41)				
Contact with cats diagnosed with toxoplasmosis in the workplace	Yes	5 (7.04)	15 (21.13)	0.495	0.67	0.21	2.14
	No	17 (23.94)	34 (47.89)				
Use of restraint techniques during procedures	Yes	15 (21.31)	39 (54.90)	0.297	0.55	0.18	1.71
	No	7 (9.86)	10 (14.08)				
Assistance from veterinary assistants during procedures	Yes	14 (19.72)	36 (50.70)	0.401	0.63	0.22	1.85
	No	8 (11.27)	13 (18.31)				
Contact with cat litter boxes or areas where cats defecate	Yes	19 (26.76)	40 (56.34)	0.623	1.42	0.35	5.87

	No	3 (4.23)	9 (12.68)				
Contact with cat feces	Yes	18 (25.35)	40 (56.34)	0.985	1.01	0.28	3.73
	No	4 (5.63)	9 (12.68)				
Cleaning cat litter boxes without gloves	Yes	16 (22.54)	31 (43.66)	0.436	1.55	0.51	4.67
	No	6 (8.45)	18 (25.35)				
Use of PPE (gloves and masks) when handling cats or cat feces	Yes	9 (12.68)	16 (22.54)	0.501	1.43	0.51	4.03
	No	13 (18.31)	33 (46.48)				
Needle-stick injury while injecting or treating a patient	Yes	10 (14.08)	28 (39.44)	0.361	0.63	0.23	1.72
	No	12 (16.90)	21 (29.58)				
History of psychiatric disease	Yes	2 (2.82)	9 (12.68)	0.318	0.44	0.09	2.25
	No	20 (28.17)	40 (56.34)				
History of tick bites	Yes	6 (8.45)	9 (12.68)	0.395	1.67	0.51	5.45
	No	16 (22.53)	40 (56.34)				

* $P < 0.05$.

** Crude odds ratio (OR).

CI: confidence interval.

Table 4. Multivariate logistic regression model of factors associated with anti-*Toxoplasma gondii* IgG seropositivity among veterinary clinic personnel.

Variable	aOR (95% CI)	*P-value*
Consumption of unpasteurized dairy products during the previous 3 months	0.21 (0.01–3.15)	0.26
Consumption of street food during the previous 3 months	0.31 (0.05–1.87)	0.20
Cat ownership	9.41 (1.60–55.23)	0.01
Contact with cats in the workplace	0.25 (0.02–3.98)	0.32
Consistent use of personal protective equipment (PPE) during work	0.10 (0.02–0.54)	0.01

aOR, adjusted odds ratio
CI: confidence interval
Variables with $p < 0.25$ in the bivariate analysis were included in the multivariate logistic regression model.

Discussion

Anti-*T. gondii* IgG antibodies were detected in 30.99% of the veterinary clinic personnel included in this study, indicating previous exposure to the parasite within this occupational group. Although the convenience sampling strategy and relatively small sample size do not allow extrapolation to all veterinary personnel in Colombia, the results provide novel epidemiological information for a population that has been scarcely investigated in the country. Furthermore, they contribute to identifying behavioral and occupational factors that may influence previous exposure to *T. gondii* in veterinary clinical settings.

The frequency of anti-*T. gondii* IgG seropositivity observed in this study is comparable to that reported by Corrales (15) and Roncalla Marroquín (16), who found a seropositivity of 36.7% and 26%, respectively, among personnel working in companion-animal veterinary facilities in Arequipa, Peru. Similar frequencies have been described among veterinarians in Portugal (26%) (17) and Finland (14.6%) (18), whereas a substantially lower anti-*T. gondii* IgG seropositivity of 8.78% was reported among

veterinary personnel in Punjab, India (19,20). These differences probably reflect variations in environmental conditions, dietary habits, hygiene practices, climatic factors, and local epidemiology rather than occupational exposure alone.

Although veterinary personnel are considered an occupational group with potential exposure to *T. gondii* because of their frequent contact with animals and clinical environments, occupational exposure itself is unlikely to be the only determinant of infection. Previous studies have shown that exposure to *T. gondii* results from the interaction of occupational, environmental, and behavioral factors, including food consumption habits, hygiene practices, and environmental contamination (17,18).

One of the principal findings of this study was the positive association between cat ownership and anti-*T. gondii* IgG seropositivity. Participants who owned cats had significantly higher odds of previous exposure than those who did not. This finding is biologically plausible because domestic cats are the definitive hosts of *T. gondii* and are responsible for shedding environmentally resistant oocysts capable of contaminating soil, water, and household environments (1). Similar observations have been reported among veterinary students, in whom frequent contact with cats was associated with the presence of anti-*T. gondii* antibodies (21). However, cat ownership should not be interpreted as an isolated causal factor. Human infection is recognized as a multifactorial process in which exposure is also influenced by environmental contamination, food handling practices, consumption of undercooked meat, inadequately washed fruits and vegetables, untreated water, and inadequate hygiene after contact with soil or cat litter boxes (22–24). Therefore, cat ownership may represent a marker of cumulative environmental exposure rather than the direct source of infection.

Another important finding was the inverse association between the consistent use of personal protective equipment and anti-*T. gondii* IgG seropositivity. Participants who consistently reported using personal protective equipment had substantially lower odds of previous exposure than those who did not. Although the cross-sectional design precludes establishing causality, this finding supports the biological plausibility that appropriate biosafety practices may reduce occupational exposure to potentially contaminated biological materials encountered during routine veterinary activities (25).

Comparable observations have been reported by Retmanasari et al. (26), who described a higher frequency of toxoplasmosis among individuals with limited adherence to personal protective measures. Similarly, Troncoso et al. (10) found that veterinary students who did not consistently use personal protective equipment while cleaning animal feces showed higher seropositivity than those who routinely adopted these protective measures. Collectively, these findings reinforce the importance of maintaining appropriate biosafety protocols in veterinary clinical practice.

Despite the high educational level of most participants, nearly half reported having only limited knowledge of toxoplasmosis. This finding agrees with that reported by Suárez-Hernández et al. (27), who identified important knowledge gaps regarding zoonotic diseases among veterinary professionals. These results highlight the need to strengthen continuing education programs on zoonotic diseases, transmission routes, and preventive measures for veterinary personnel.

Most participants reported routine occupational contact with both dogs and cats, a finding similar to that described by Alemán (28), who reported that 57.1% of veterinary personnel routinely handled these animal species. Participants also recognized several potential routes of *T. gondii* transmission, including contaminated meat, inadequately washed fruits and vegetables, untreated drinking water, and contact with cat litter boxes. These observations are consistent with current evidence demonstrating the environmental persistence of *T. gondii* oocysts and their importance in foodborne and waterborne transmission (22).

From a diagnostic perspective, ELISA remains one of the most widely used methods for detecting anti-*T. gondii* IgG antibodies in epidemiological studies because of its good sensitivity, specificity, and suitability for identifying previous exposure in large populations (29,30). Using this technique in the present study allowed reliable identification of individuals previously exposed to the parasite.

Interestingly, no statistically significant associations were observed between anti-*T. gondii* IgG seropositivity and most demographic, dietary, behavioral, and occupational exposure variables evaluated in this study. Although these findings may partly reflect the limited statistical power resulting from the sample size, they should not be interpreted as evidence of the absence of associations with demographic or occupational variables. Evaluating these variables remains epidemiologically relevant because they represent potential confounders that should continue to be assessed in future occupational studies.

Several limitations should be considered when interpreting these findings. First, the convenience sampling strategy and the relatively small sample size limit the external validity of the results. Second, the sample size was also constrained by the analytical resources available for serological testing, which limited the number of participants that could be included in the study. Third, the cross-sectional design does not allow temporal or causal relationships to be established. Fourth, the limited number of seropositive participants reduced the statistical power of the multivariate model; therefore, the identified associations should be interpreted as exploratory and hypothesis-generating rather than definitive. As reflected by the wide confidence intervals observed for some variables, the precision of the estimated odds ratios was limited. Nevertheless, this study provides the first evidence of anti-*T. gondii* IgG seropositivity among veterinary clinic personnel in Medellín and identifies potentially modifiable factors that may contribute to strengthening occupational biosafety strategies and guiding future multicenter investigations.

Conclusion

Overall, this study provides evidence of previous exposure to *T. gondii* among veterinary clinic personnel in Medellín and identifies cat ownership and consistent PPE use as variables associated with the observed seropositivity pattern. Strengthening biosafety practices and educational strategies on zoonotic diseases may help reduce potential occupational exposure and improve preventive practices in veterinary clinical settings.

Acknowledgments

The authors thank the Remington University Corporation, particularly the Faculty of Veterinary Medicine, for its institutional support throughout all stages of this project. We also express our sincere gratitude to the Colegio Mayor de Antioquia University Institution for providing access to its facilities, especially the Ángela Restrepo Moreno Research Laboratory.

Conflict of Interest

The authors declare no conflicts of interest that could have influenced the results or interpretation of this study.

Ethical approval

The study protocol was reviewed and approved by the Ethics Committee of the Faculty of Health Sciences of Remington University Corporation (Approval No. 092022). All participants provided written informed consent before enrollment. Personal information was treated confidentially and analyzed exclusively for research purposes in accordance with national and international ethical guidelines for research involving human participants.

Artificial Intelligence Statement

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist with English language editing, grammar correction, and improvement of text clarity. After using this tool, the authors reviewed and edited the content as

needed and take full responsibility for the content of the published article.

References

1. Zhou P, Chen Z, Li HL, Zheng H, He S, Lin RQ, et al. *Toxoplasma gondii* infection in humans in China. Parasit Vectors. 2011; 4:165. http://doi.org/10.1186/1756-3305-4-165
2. Mimica F, Torres M, Padilla O. Toxoplasmosis, zoonosis parasitaria prevalente en Chile: Recuento y desafíos. Rev Chilena Infectol. 2015;32(5):541-9. http://doi.org/10.4067/S0716-10182015000600008
3. Grandía R, Entrena Á, Cruz J, Ginorio D, Domenech I, Alfonso A. Nivel de conocimiento sobre Toxoplasmosis en propietarios y su asociación con la seroprevalencia en *Felis catus* en La Habana. Rev Salud Anim. 2013;35(2):126-35.
4. Onduru OG, Aboud S. Prevalence and risk factors for typical signs and symptoms of Toxoplasmosis in children born to at-risk pregnant women attending prenatal care in Temeke District, Tanzania. Sci Afr. 2021;11: e00690. http://doi.org/10.1016/j.sciaf.2020.e00690
5. Milne G, Webster JP, Walker M. *Toxoplasma gondii*: An underestimated threat? Trends Parasitol. 2020;36(12):959-69. http://doi.org/10.1016/j.pt.2020.08.005
6. Liu Q, Wang ZD, Huang SY, Zhu XQ. Diagnosis of toxoplasmosis and typing of *Toxoplasma gondii*. Parasit Vectors. 2015; 8:292. http://doi.org/10.1186/s13071-015-0902-6
7. Cañón-Franco W, López-Orozco N, Gómez-Marín J, Dubey JP. An overview of seventy years of research (1944-2014) on toxoplasmosis in Colombia, South America. Parasit Vectors. 2014; 7:427. http://doi.org/10.1186/1756-3305-7-427
8. Ramírez AM, Ríos YK, Galvis NF, Entrena E, Mariño NV, Rangel DM. Seroprevalencia y detección molecular de *Toxoplasma gondii* en donantes de un banco de sangre de Cúcuta, Colombia. Biomedica. 2019;39(Supl 2):144-56. http://doi.org/10.7705/biomedica.v39i4.4288
9. Campo D, Discuviche M, Blanco P, Montero Y, Orozco K, Assia Y. Detección de *Toxoplasma gondii* por amplificación del gen B1 en carnes de consumo humano. Infectio. 2014;18(3):93-9. http://doi.org/10.1016/j.infect.2014.05.001
10. Troncoso TI, Fischer WC, Cuevas HA, Cespedes-Cortes B, Valenzuela CA, Flores CY. Seroprevalencia de *Toxoplasma gondii* en estudiantes con riesgo ocupacional. Rev Chilena Infectol. 2022;39(3):260-4. http://doi.org/10.4067/S0716-10182022000200260
11. Cortés LJ, Flórez-Sánchez AC, Montealegre-Santa IA, Valbuena YA. Seroprevalencia de la toxoplasmosis y factores relacionados con las enfermedades transmitidas por alimentos en trabajadores de plantas de beneficio animal en cinco ciudades capitales de Colombia, 2008. Nova. 2009;7(11):66-70. http://doi.org/10.22490/24629448.419
12. Smith NC, Goulart C, Hayward JA, Kupz A, Miller CM, van Dooren GG. Control of human toxoplasmosis. Int J Parasitol. 2021;51(2-3):95-121. http://doi.org/10.1016/j.ijpara.2020.11.001
13. Aguirre AA, Longcore T, Barbieri M, Dabritz H, Hill D, Klein P, et al. The one-health approach to toxoplasmosis: Epidemiology, control, and prevention strategies. EcoHealth. 2019;16(2):378-90. http://doi.org/10.1007/s10393-019-01405-7
14. Diagnostic Bioprobes. Toxo IgG - ELISA. Dia.Pro Diagnostic Bioprobes; 2021. [Internet]. Available from: https://www.diapro.it/products/toxo-igg-elisa. [Accessed 10th June 2026].
15. Corrales F. Prevalencia de toxoplasmosis subclínica en el personal de establecimientos de atención médica veterinaria para animales de compañía en la ciudad de Arequipa - 2013 [tesis de pregrado]. Arequipa: Universidad Católica de Santa María; 2014.
16. Roncalla Marroquín MÁ. Prevalencia de toxoplasmosis sub-clínica de personal en centros de atención médica veterinaria de animales de compañía, en la ciudad de Moquegua - 2017 [tesis de pregrado]. Arequipa: Universidad Católica de Santa María; 2018.

17. Almeida D, Coelho C, Ribeiro A, Lopes AP, Cardoso L, Costa Á. Prevalence of *Toxoplasma gondii* antibodies and risk factors among veterinary practitioners in Portugal: A case-control study. Pathogens. 2022;11(10):1217. http://doi.org/10.3390/pathogens11101217
18. Siponen AM, Kinnunen PM, Koort J, Kallio-Kokko H, Vapalahti O, Virtala AMK, et al. *Toxoplasma gondii* seroprevalence in veterinarians in Finland: Older age, living in the countryside, tasting beef during cooking and not doing small animal practice associated with seropositivity. Zoonoses Public Health. 2019;66(2):207-15. http://doi.org/10.1111/zph.12550
19. Behera P. Seroprevalence of *Toxoplasma gondii* infection among veterinary personnel in Punjab, India. medRxiv [Preprint]. 2020. http://doi.org/10.1101/2020.10.20.20216556
20. Thakur R, Singh BB, Sharma R, Gill JPS, Aulakh RS. Seroprevalence and risk factor investigation for *Toxoplasma gondii* infection among veterinary personnel and animal handlers in Punjab, India. Prev Med Rep. 2022;25:101636. http://doi.org/10.1016/j.pmedr.2021.101636
21. Araújo FR, Carvalho CME, Balbuena CB. Anticorpos contra *Toxoplasma gondii* em estudantes de medicina veterinária e factores de risco associados. Cienc Rural. 2000;30(6):1017-20.
22. Shapiro K, Bahia-Oliveira L, Dixon B, Dumètre A, de Wit LA, VanWormer E. Environmental transmission of *Toxoplasma gondii*: Oocysts in water, soil and food. Food Waterborne Parasitol. 2019;15: e00049. http://doi.org/10.1016/j.fawpar.2019.e00049
23. Wehbe K, Pencole L, Lhuaire M, Sibiude J, Mandelbrot L, Villena I. Hygiene measures as primary prevention of toxoplasmosis during pregnancy: A systematic review. J Gynecol Obstet Hum Reprod. 2022;51(3):102300. http://doi.org/10.1016/j.jogoh.2021.102300
24. Hussain M, Stitt V, Szabo E, Nelan B. *Toxoplasma gondii* in the food supply. Pathogens. 2017;6(2):21. http://doi.org/10.3390/pathogens6020021
25. Meoño-Sánchez ER. Los riesgos laborales de la profesión de médico veterinario. Rev Electron Vet. 2017;18(1):1-11.
26. Retmanasari A, Widartono BS, Wijayanti MA, Artama WT. Prevalence and risk factors for toxoplasmosis in Middle Java, Indonesia. EcoHealth. 2017;14(1):162-70. http://doi.org/10.1007/s10393-016-1198-5
27. Suárez-Hernández M, Llorens-Blanco F, Cepero-Rodríguez O, Retureta-Milian M, González-Martí T. Conocimientos que tienen médicos veterinarios no vinculados a la salud pública en la provincia Ciego de Ávila, Cuba sobre algunas zoonosis. Rev Biomedica. 2005;16(4):221-6. http://doi.org/10.32776/revbiomed.v16i4.422
28. Alemán A. Titulación de anticuerpos contra Toxoplasma con el método de hemaglutinación indirecta en médicos veterinarios de centros de atención veterinaria en la ciudad de Cusco - 2014 [tesis de pregrado]. Arequipa: Universidad Católica de Santa María; 2015.
29. Smith SB, Repetti CF. Evaluation of a rapid screening immunoassay for antibodies to *Toxoplasma gondii*. J Clin Microbiol. 1987;25(11):2207-8. http://doi.org/10.1128/jcm.25.11.2207-2208.1987
30. Millar PR, Daguer H, Vicente RT, Costa T, Sobreiro LG, Amendoeira MRR. *Toxoplasma gondii*: Estudo sorológico em profissionais expostos a animais e fatores de risco associados. Cienc Rural. 2007;37(5):1356-61.