



RESEARCH ARTICLE

Seroprevalence of specific antibodies against *Toxoplasma gondii* among patients with malignant tumors in Dali, Yunnan province

Du, S.T.^{1*}, Yang, Y.W.¹, Wu, T.F.¹¹Department of Human Parasitology, School of Basic Medicine, Dali University, Yunnan 671000, China

*Corresponding author: dudunolove@163.com

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ABSTRACT

To investigate the seroprevalence of *Toxoplasma gondii* infection in patients with malignant tumors, we aimed to provide insights into improving the prognosis and quality of life of these patients. A total of 721 patients with malignant tumors admitted to the Affiliated Hospital of Dali University from November 2020 to May 2022, along with 100 healthy volunteers from the hospital during the same period, were enrolled. Demographic data and serum samples were collected, and serum-specific IgG and IgM antibodies against *T. gondii* were detected using an enzyme-linked immunosorbent assay. Patients were considered positive for *T. gondii* infection if either IgG or IgM antibodies were detected. The seroprevalence of specific IgG and IgM antibodies was compared between patients with malignant tumors and healthy volunteers. The positivity rates for anti-*T. gondii* antibodies in patients with malignant tumors was significantly higher than that in healthy volunteers (31.2% vs. 13.0%; $\chi^2 = 14.141$, $P < 0.01$). Pairwise comparisons revealed that the positive rates of serum anti-*T. gondii* antibodies in patients with various types of malignant tumors were significantly higher than those in healthy volunteers (all P values < 0.01). There was no statistically significant difference in the average age and sex composition between patients with malignant tumors and healthy volunteers ($P > 0.05$). The results indicate a high seroprevalence rate of *T. gondii* infections among patients with malignant tumors, which was significantly higher than that among healthy volunteers.

Keywords: *Toxoplasma gondii*; malignant tumor; seroprevalence.

INTRODUCTION

Toxoplasma gondii is an opportunistic pathogenic parasite that infects nucleated human and animal cells. It can cause zoonotic toxoplasmosis, directly threatening human health and animal husbandry (Zhu *et al.*, 2023). Cats and other feline animals are the ultimate hosts of *T. gondii*, whereas humans and most warm-blooded animals serve as intermediate hosts. Owing to the widespread presence of intermediate hosts, *T. gondii* has become prevalent worldwide, with approximately one-third of the global population infected (Inci *et al.*, 2023). In China, the infection rate of *T. gondii* is approximately 7.86% (Shen & Yu, 2019). Reports have shown that the infection rate of *T. gondii* is relatively high in Guizhou Province, reaching 16.93% (Chen *et al.*, 2005). In Hubei Province, the infection rate of *T. gondii* IgG antibodies is approximately 2.44% (Shen *et al.*, 2020), whereas in Yunnan Province, it is around 7.84% (Li *et al.*, 2019). These findings highlight significant regional differences in the infection rate of *T. gondii*, which may be attributed to unique geographical locations, hygiene conditions, climatic factors, and lifestyle habits of different regions. *T. gondii* infections are generally asymptomatic. However, in individuals with congenital infections or weakened immune systems, the infection can lead to severe toxoplasmosis, causing miscarriages and stillbirths in pregnant women and animals. Individuals with weakened immune

systems, such as patients with AIDS or cancer and organ transplant recipients, are at high risk, and complications, including *Toxoplasma* encephalopathy and eye diseases, may arise, which can be fatal in severe cases (Rabaan *et al.*, 2023).

Cancer is the second leading cause of death globally, with approximately 9.6 million deaths worldwide in 2018 and over 14 million new patients diagnosed each year (Siegel *et al.*, 2023). It is estimated that 23.6 million new cancer cases will be diagnosed annually by 2030, with cancer-related deaths worldwide expected to reach 11 million by 2030 (Chen *et al.*, 2016). China, which has the largest global population, is witnessing increasing cancer incidence and mortality rates annually. In 2016, China reported approximately 4.64 million new cancer cases and 2.41 million cancer-related deaths, leading to a high mortality rate of 51.92% (Zheng *et al.*, 2023). By 2020, China had the highest number of patients with cancer globally. Cancer is a leading cause of death in both developed and developing countries, posing a serious threat to human health and life. The infection rate of *T. gondii* in patients with malignant tumors is 26.57% (Yang & Shen, 2021). Therefore, it is crucial for medical personnel to pay special attention to detecting *T. gondii* when treating patients with tumors in clinical practice. Yunnan is a province in southwestern China with a significant population of ethnic minorities, sharing borders with Laos, Vietnam, Myanmar, and other countries. Multiple ethnic minorities live across borders, and local specialties often

involve using raw pork as the main ingredient for dishes, such as “raw skin” and “chopped raw,” increasing the risk of *T. gondii* infection in the regional population. However, few studies have focused on patients with malignant tumors infected with *T. gondii* in Yunnan. This study utilized an enzyme-linked immunosorbent assay to detect anti-*Toxoplasma gondii* IgG and IgM antibodies in the serum of patients with malignant tumors in the Yunnan region. This study aimed to compare serum antibody levels between patients with malignant tumors and healthy individuals undergoing physical examinations. To assess the infection of *T. gondii* in patients with various types of malignant tumors, we analyzed specific antibodies against *T. gondii* in their serum, providing fundamental data for the prevention and treatment of toxoplasmosis in patients with different types of malignant tumors.

MATERIALS AND METHODS

Research participants

A total of 721 patients with malignant tumors who received treatment at the Affiliated Hospital of Dali University between November 2020 and May 2022 were selected as study participants. Among them, there were 94 cases of lung cancer, 90 of rectal cancer, 92 of breast cancer, 69 of colon cancer, 74 of gastric cancer, 63 of liver cancer, 60 of thyroid cancer, 40 of bladder cancer, 30 of cervical cancer, 31 of endometrial cancer, 43 of esophageal cancer, and 35 of prostate cancer. All cases were confirmed via pathological examination. Additionally, 100 healthy participants who underwent physical examinations at the hospital during the same period were selected as healthy controls. The medical records of both patients with malignant tumors and healthy individuals were collected. Data regarding sex, age, nationality, and residence were also extracted.

Materials

Reagents and Instruments: Serum-specific *Toxoplasma* IgG and IgM antibody assay kits were purchased from Shanghai Enzyme-Linked Biotechnology Co., Ltd. (202109; 202204).

Methods

Detection Method: Venous blood was collected from all participants and centrifuged at 3000 rpm for 5 min (centrifugation radius: 15 cm). Serum was collected, and anti-*Toxoplasma* IgG and IgM antibodies were detected using an enzyme-linked immunosorbent assay.

Analysis

Statistical Analysis: Excel 2020 was used to establish the database, and SPSS 26.0 was used for data analysis. Measurement data were expressed as mean ± standard deviation, and group comparisons were conducted using one-way ANOVA. The adoption rate of the count data was compared using the χ^2 test for multigroup comparisons, and the Bonferroni correction method was applied for pairwise comparisons. Differences were considered statistically significant at $P < 0.05$.

RESULTS

General situation

Of the 94 patients with lung cancer, 66 were men and 28 were women. The average age was 62.67 ± 9.28 years, ranging from 37 to 86 years. Among the 90 patients with rectal cancer, 55 were men and 35 were women, with ages ranging from 27 to 83 years and an average age of 60.17 ± 12.59 years. All 92 patients with breast cancer were women, with an average age of 52.99 ± 9.37 years, ranging from 27 to 79 years. Of the 69 patients with colon cancer, 33 were men and 36 were women, with an average age of 60.29 ± 12.31 years. Among the 74 patients with gastric cancer, 48 were men and 26 were women, with an average age of 57.50 ± 11.27 years, ranging from

30 to 79 years. Of the 63 patients with liver cancer, 47 were men and 16 were women, with an average age of 56.51 ± 11.02 years, ranging from 23 to 81 years. Of the 60 patients with thyroid cancer, seven were men and 53 were women, with an average age of 43.07 ± 10.87 years, ranging from 20 to 64 years. Among the 40 patients with bladder cancer, 35 were men and five were women, with an average age of 59.78 ± 10.21 years, ranging from 41 to 81 years. All 30 patients with cervical cancer were women, with an average age of 49.60 ± 7.73 years, ranging from 30 to 65 years. All 31 patients with endometrial carcinoma were women, with ages ranging from 36 to 73 years and an average age of 53.90 ± 8.11 years. Among the 43 patients with esophageal cancer, 42 were men and one was a woman, with an average age of 57.49 ± 10.47 years, ranging from 13 to 77 years. All 35 patients diagnosed with prostate cancer were men, with an average age of 72.37 ± 7.29 years, ranging from 54 to 86 years. Among the 100 healthy participants, 50 were men and 50 were women, with an average age of 54.29 ± 10.93 years, ranging from 30 to 79 years. There was no significant difference in mean age ($F = 2.573, P > 0.05$) and sex composition between patients with malignant tumors and healthy participants ($\chi^2 = 0.03, P > 0.05$). Among the 12 types of malignant tumors, men were predominantly diagnosed with lung, rectal, gastric, liver, bladder, and esophageal cancers, whereas women were more commonly diagnosed with colon and thyroid cancers (Figure 1).

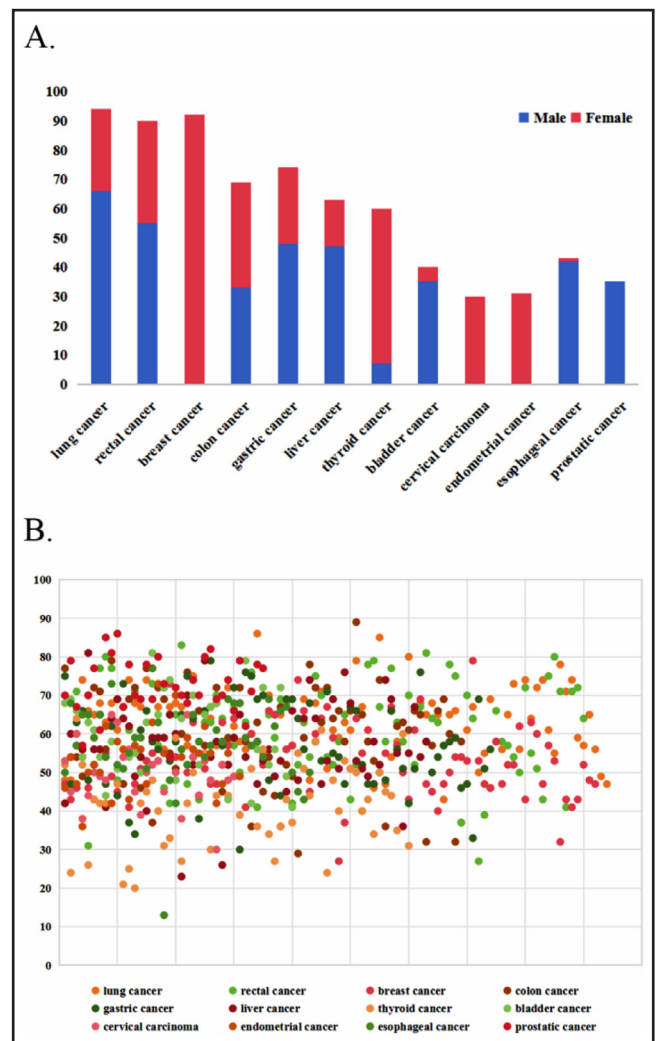


Figure 1. The characteristics of 721 patients with malignant tumors. (A) Age characteristics of 721 patients with malignant tumors. (B) Sex characteristics of 721 patients with malignant tumors.

Comparison of *Toxoplasma* infection rates

Among the 721 patients with malignant tumors, 231 (32.04%) tested positive for anti-*Toxoplasma* antibodies. Among the 100 healthy participants, 13 (13%) tested positive for anti-*Toxoplasma* antibodies. The positivity rate for anti-*Toxoplasma* antibodies in patients with malignant tumors was significantly higher than in healthy participants ($\chi^2 = 14.141$, $P < 0.01$).

The positivity rates for serum anti-*Toxoplasma* IgG and IgM antibodies were 21.22% (153/721) and 9.99% (72/721), respectively, in patients with malignant tumors. In the 100 healthy participants, the positivity rates of serum anti-*Toxoplasma* IgG and IgM antibodies were 8.00% (8/100) and 5.00% (5/100), respectively. There was a significant difference in the positive rate of anti-*Toxoplasma* IgG antibodies between patients with malignant tumors and healthy participants ($\chi^2 = 9.74$, $P < 0.05$). However, there was no significant difference in the positive rate of anti-*Toxoplasma* IgM antibodies between the two groups ($\chi^2 = 2.57$, $P > 0.05$).

The positive rates of anti-*Toxoplasma* IgG antibodies in patients with gastric, bladder, colorectal, thyroid, lung, cervical, endometrial, and liver cancers were significantly higher than those in healthy participants ($\chi^2 = 10.14$, 7.37, 10.63, 6.14, 6.92, 4.75, and 4.38, respectively; $P < 0.05$). There was no significant difference in the positive rate for anti-*Toxoplasma* IgG antibodies between the other cancer types and the healthy control group ($P > 0.05$). The positive rate of anti-*Toxoplasma* IgM antibodies in cervical and endometrial cancers was significantly higher than that in the healthy control group ($\chi^2 = 4.54$, $P < 0.05$). However, there was no significant difference in the positive rate of anti-*Toxoplasma* IgM antibodies in other cancer types between the cancer group and the healthy control group ($P > 0.05$). Among the patients with 12 different types of malignant tumors, patients with gastric cancer had the highest positivity rate for anti-*Toxoplasma* IgG antibody, whereas patients with cervical and endometrial cancer had the highest positivity rate for anti-*Toxoplasma* IgM antibodies. However, there was no significant difference in the positive rates of anti-*Toxoplasma* IgG and IgM antibodies among different cancer types ($\chi^2 = 3.96$, 11.26, $P > 0.05$) (Table 1).

DISCUSSION

Toxoplasma gondii is an opportunistic, pathogenic protozoan. Studies have shown that infection with *Toxoplasma gondii* can lead to fatal clinical outcomes in patients with malignant tumors.

Wang et al. (2017) integrated a large amount of data from an electronic database of patients with malignant tumors having toxoplasma infection. They conducted a meta-analysis using random- or fixed-effects models to evaluate the prevalence and odds ratio of toxoplasma infection in immunocompromised individuals. The study found that the infection rate of toxoplasma in patients with malignant tumors was 26.0%, whereas in the healthy control group, it was 12.1%. This difference was statistically significant, suggesting that *Toxoplasma* infection was significantly associated with an increased risk of malignancy (OR=2.89). According to an investigation conducted in Taizhou, the serum anti-*Toxoplasma* antibody positivity rate of 105 patients with cancer was 23.81%, which was significantly higher than that of the healthy control group (1.25%) (Lin et al., 2022). In an investigation of *Toxoplasma* infection in patients with malignant tumors in Wuhu City, Anhui Province, the infection rate of patients with malignant tumors combined with *Toxoplasma* was 15.68% (Liu et al., 2021). In a study conducted in Lanzhou, the infection rate of *Toxoplasma gondii* in patients with cancer was 8.87%, which was significantly different from that in healthy controls (2.90%) (Sun et al., 2008). However, a comparative study of *Toxoplasma* infection rates in patients with various systemic malignancies has not yet been conducted.

The results of this study showed that the positive detection rate of anti-*T. gondii* IgG antibodies in patients with malignant tumors was 21.22%, which was significantly higher than that in the healthy population ($P < 0.05$). However, there was no statistically significant difference in the positive detection rate of anti-*T. gondii* IgM antibodies compared with that in the healthy control group ($P > 0.05$), which is consistent with both domestic and international reports (Zhou et al., 2018; Chen et al., 2019). Previous serological investigations have shown that among patients with different types of malignant tumors, such as lung, rectal, and prostate cancer in

Table 1. Positive detection of serum IgG and IgM antibodies against *Toxoplasma gondii* in patients with malignant tumors and healthy people

Research object	cases	IgG antibody positive cases (%)	IgM antibody positive cases (%)	IgG/IgM antibody double positive cases (%)	IgG or IgM antibody positive cases (%)
Lung cancer	94	20 (21.28)	10 (10.64)	9 (9.57)	30 (31.91)
Rectal cancer	90	20 (22.22)	9 (10.00)	9 (10.00)	29 (32.22)
Breast cancer	92	16 (17.39)	17 (18.48)	17 (18.48)	33 (35.87)
Colon cancer	69	18 (26.09)	8 (11.59)	8 (11.59)	26 (37.68)
Gastric cancer	74	19 (25.68)	7 (9.46)	7 (9.46)	26 (35.14)
Liver cancer	63	12 (19.05)	7 (11.11)	7 (11.11)	19 (30.16)
Thyroid cancer	60	13 (21.67)	8 (13.33)	8 (13.33)	21 (35.00)
Bladder cancer	40	10 (25.00)	2 (5.00)	2 (5.00)	12 (30.00)
Cervical carcinoma	30	8 (26.67)	5 (16.67)	5 (16.67)	13 (43.33)
Endometrial cancer	31	4 (12.90)	4 (13.33)	4 (13.33)	8 (25.81)
Esophageal cancer	43	7 (16.28)	1 (23.26)	1 (23.26)	8 (18.60)
Prostatic cancer	35	6 (17.14)	0 (0.00)	0 (0.00)	6 (17.14)
Healthy volunteers	100	8 (8.00)	5 (5.00)	5 (5.00)	13 (13.00)

Anhui Province, the infection rate of *Toxoplasma gondii* in patients with cervical cancer is as high as 11.25%, whereas the infection rate in patients with breast cancer is as low as 1.79% (Wang *et al.*, 2015). Chen Yueqin (Chen *et al.*, 2019) reported that, based on the detection results of serum IgG antibodies against *Toxoplasma gondii* in Hangzhou, the highest positive detection rate was observed in patients with liver cancer (25.68%) and the lowest in patients with leukemia (19.44%). However, there was no statistically significant difference in the positivity rate of *Toxoplasma gondii* among patients with different types of cancers. The results of this study showed that among patients with various types of malignant tumors, those with gastric cancer had the highest positive rate of anti-*T. gondii* IgG antibodies (25.68%), which was higher than the rates reported in Anhui, Hainan, and Lanzhou (Lian *et al.*, 2010; Wang *et al.*, 2015; Li *et al.*, 2019). The positivity rate for anti-*T. gondii* IgG antibodies in patients with esophageal cancer was the lowest at 16.28%, which was similar to the rate reported in Hainan (Li *et al.*, 2019). In addition, the detection rate of anti-*T. gondii* IgG antibodies in patients with liver cancer was lower than that reported in other regions of China (Huang *et al.*, 2018; Li, 2019; Xia & Huang, 2021).

In conclusion, the results of this study showed that the positivity rate for anti-*T. gondii* IgG antibodies in patients with malignant tumors was significantly higher than that in healthy participants. However, there was no statistically significant difference in the detection rate of *T. gondii*-specific antibodies among patients with different types of malignant tumors. The positivity rate for serum anti-*T. gondii* IgG antibodies in patients with various types of malignant tumors was not specific to sex, age, place of residence, or nationality. Considering the high infection rate of *T. gondii* in patients with malignant tumors and the atypical symptoms of *Toxoplasma gondii* infection, it is advisable to perform early screening for *T. gondii* in patients with malignant tumors. Simultaneously, efforts should be made to enhance the promotion of toxoplasmosis prevention and control to increase patient awareness and thereby prevent serious harm caused by toxoplasmosis.

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Conflict of interest statement

The authors declare no conflict of interest.

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