

Seropositivity of *Anti-Toxoplasma gondii* IgG among type 2 diabetes mellitus patients

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ABSTRACT

Introduction. An estimated one-third of people worldwide are thought to be affected by toxoplasmosis, a common tropical disease with a wide geographic range. The most common form of DM, namely type 2 diabetes, arises from a combination of insulin resistance and inadequate compensatory insulin secretion.

Methods. A case-control study was conducted from November 2022 to January 2023 of type 2 diabetic patients who attended outpatient clinics. Overall, 96 patients who had diabetes were screened for *T. gondii* seroprevalence.

Results. By the ELISA method, the IgG antibodies in diabetic patients were 90.63%, compared with a control group whose positive *T. gondii* IgG antibodies were 28%. The seropositivity of *T. gondii* IgG revealed that the patients living in urban areas were slightly more than those in rural areas, at 58.3% and 32.3%, respectively. The results showed that diabetic patients >60 years old had the highest rate of seropositive *T. gondii* infections (40.23%), while those ≤30 years old had the lowest rate (4.60%), with the mean of T2DM patients being 7.15 ± 1.94 .

Conclusion The current study revealed a high prevalence of *T. gondii* IgG among T2DM patients. The rate of seropositivity for *T. gondii* among patients living in the urban areas was slightly higher than in those in rural areas. The objective of the research was to ascertain whether *T. gondii* seropositivity and type 2 diabetes might be related.

Keywords: *Toxoplasma gondii*, toxoplasmosis, T2DM, IgG, seropositivity

INTRODUCTION

T. gondii, a member of the *Apicomplexa phylum*, has developed the capability to invade a broad spectrum of cell types in both mammals and birds [1,2]. *Toxoplasma gondii* stands as the causal agent behind toxoplasmosis, a zoonotic disease of significant medical and veterinary significance [3]. An estimated one-third of people worldwide are thought to be affected by toxoplasmosis, a common tropical disease with a wide geographic range [4]. The dissemination of *T. gondii* can be influenced by dietary preferences and environmental elements. For instance, the eating of raw or inadequately cooked meat has been associated with the transmission of the parasite due to the presence of tissue cysts [5]. Transmis-

sion can also occur through oocysts released in feline feces, even without direct contact with the animal. Domesticated cats have a lower likelihood of contamination and oocyst production compared to stray or rural cats [6]. In individuals with a competent immune system, *T. gondii* infections often manifest no symptoms or mild effects, although the persistence of the parasite can extend for varying durations, potentially spanning the individual's entire lifespan [7]. During pregnancy, primary infection can lead to the transmission of the parasite to the fetus, resulting in severe symptoms, fetal mortality, and complications following birth. However, in immunocompromised individuals, such as those afflicted with AIDS or undergoing immunosuppres-

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sive therapy, recurring chronic toxoplasmosis can lead to tissue degradation and potentially fatal *Toxoplasma encephalitis* [8]. *T. gondii* significantly contributes to posterior uveitis in normally healthy adults or teenagers [9]. Based on economic considerations and the years of life lost due to the illness, human toxoplasmosis has been identified as one of the prevalent foodborne infectious diseases in the United States [10].

Diabetes mellitus (DM) is undeniably one of humanity's earliest disorders, with historical references tracing back around 3000 years to an ancient Egyptian manuscript [11]. The most common form of DM, namely type 2 diabetes (formerly referred to as non-insulin dependent DM), is caused by an interaction between insulin resistance with insufficient compensatory insulin production [12]. The worldwide prevalence of type 2 diabetes mellitus (DM) is on the rise, leading to an emerging epidemic in specific regions. Projections indicate that the affected population will double in the next decade due to an aging demographic, thereby exacerbating the strain on the healthcare systems [13].

The existing body of knowledge predominantly associates *T. gondii* with the development of diabetes [14-16]. A comprehensive meta-analysis of research concerning the relationship between chronic toxoplasmosis and diabetes mellitus implies that chronic toxoplasmosis could potentially be a risk factor for T2DM [16]. Nevertheless, studies have revealed significantly lower prevalence of *T. gondii* among type 1 diabetes (T1DM) patients in Colombia [17]. A prospective study involving elderly latinos in the United States found no observable connection between *T. gondii* infection and diabetes mellitus [18]. Given the contradictory findings of earlier studies on the relationship between *T. gondii* infection and diabetes mellitus, the study's objectives are to determine the potential correlation between *T. gondii* seropositivity and T2DM, as well as to examine the risk factors associated with *T. gondii* infection.

MATERIALS AND METHODS

Population surveyed

A case-control study was conducted from November 2022 to January 2023 from type 2 diabetic patients who attended outpatient clinics in Basrah City, Iraq. Overall, 96 patients who had diabetes were screened for *T. gondii* seroprevalence and categorized into two groups: 96 patients with *T. gondii* as the studied group and 50 healthy individuals. All the included individuals were between the ages of ≤ 30 to ≥ 60 years old and gender (48 male and 48 female).

Laboratory testing

We tested ninety-six sera from type 2 diabetic patients; five ml of venous blood were taken from each participant during a clinical examination to check for Anti-*Toxoplasma gondii* IgG presence. The serum was kept in Eppendorf tubes in deep frozen at -20°C until use. We determined the level of fasting blood sugar and HBA1C based on the manufacturer's instructions (COBAS INTEGRA® 400 plus, Roche Diagnostics, Germany). Serum samples were centrifuged at 5000 RPM for five minutes at 4°C as part of laboratory procedures [19]. The HerpeSelect 1 IgG ELISA test kit (SunLong Biotech Co., LTD.) was used to determine *T. gondii* seropositivity by the manufacturer's instructions.

Ethical approval and informed consent

Ethical consent was obtained from patients and healthy volunteers participating in the study before collecting samples.

Statistical analyses

Data were analyzed through Version 26 of the Statistical Package for the Social Sciences (SPSS Inc.) software. To describe the study population, the mean and standard deviation (SD) were determined. To assess the statistical significance of the data difference, the Chi-square test (χ^2 -test) was used. Statistical significance is defined as P values < 0.05 .

RESULTS

The study includes 96 diabetes mellitus patients type 2 from a different out clinic in the Basrah governorate categorized by gender and age groups. Their ages range from ≤ 30 to > 60 years with a mean of 56 ± 14.06 years. The study's participants were divided into five age categories and the majority of the participants are elderly patients over the age of 60 years with a rate of 39.6%. By the ELISA method, the test for the seroprevalence of *T. gondii* in diabetic patients was measured, and the IgG antibodies were 90.63%, compared the results of those collected from 50 healthy individuals as a control group, for which positive *T. gondii* IgG antibodies were 28%, which is the statistically significant ($p=0.03$) (Table 1).

Furthermore, the seropositivity of *T. gondii* IgG among the T2DM patients revealed that the patients living in urban areas were slightly higher in infection than those in rural areas, at 58.3% and 32.3%, respectively. According to the results in diabetic patients, 45.8% of females and 44.8% of males were positive for anti *T. gondii* IgG. The results showed that diabetic patients > 60 years old had the highest rate of seropositive *T. gondii* infections (40.23%), while those ≤ 30 years old had the lowest rate (4.60%) with the mean of T2DM patients is 7.15 ± 1.94 (Figure 1).

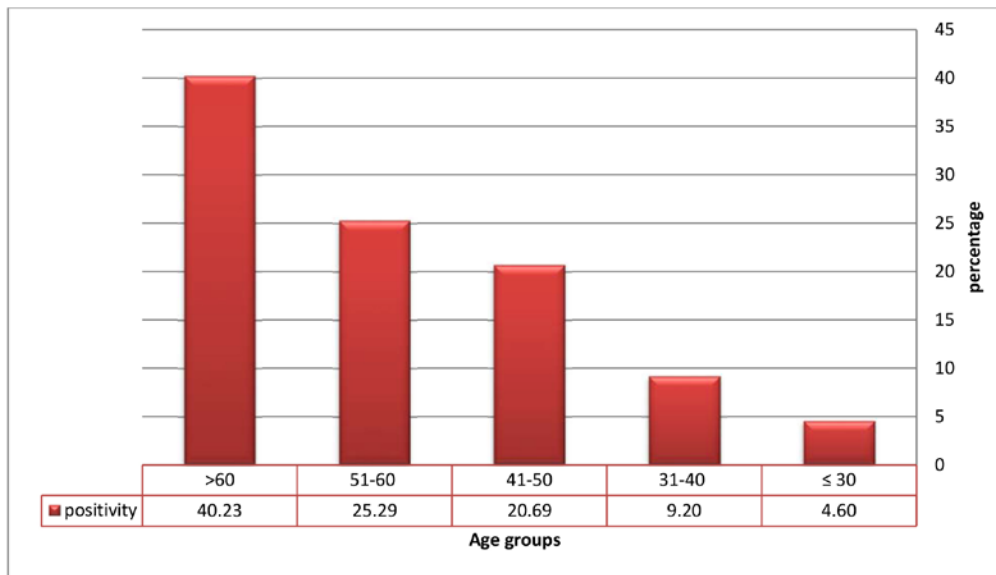


FIGURE 1. The seropositivity of *T. gondii* IgG antibodies according to age groups

Age Group (years)	Gender		Total %
	Female %	Male %	
≤30	2.1	3.1	5.2
31-40	6.3	4.2	10.4
41-50	10.4	10.4	20.8
51-60	13.5	10.4	24.0
>60	17.7	21.9	39.6
Total	50.0	50.0	100.0
No. seropositive of <i>T. gondii</i> IgG antibodies infection %	44.8	45.8	90.63
Mean ± SD	56 ± 14.06		
p value	0.03		

*SD: Standard deviation

DISCUSSION

There is considerable debate regarding the link between the risk of diabetes and the incidence of *T. gondii* infection. It is essential to evaluate the potential connection between toxoplasmosis and diabetes mellitus. The severity and complications of *T. gondii* infection in people with type 1 diabetes (T1DM) and type 2 diabetes (T2DM), including people with gestational diabetes (GDM) patients, has been researched in several prior studies. Type 2 diabetes mellitus prevalence is a global public health issue that has been sharply rising in both industrialized and developing nations in recent years [20]. The study aimed to estimate the seroprevalence of Anti-*Toxoplasma gondii* IgG infection among patients with type 2 diabetes. Type 2 diabetes mellitus is a complex metabolic disease, and due to the immunodeficiency of T2DM patients, they are susceptible to infection with many infections, including *T. gondii* [14,21].

The total *T. gondii* IgG antibodies seroprevalence in T2DM patients was 90.63%, which is exception-

nally high and the data of T2DM patients, including age groups, sex, and region of residence, were collected with the determination of HBA1C for each patient. In Iraq, a prior study by Entsar (2017) showed that about 96 out of 172 diabetic patients had a seropositive result of 55.81% for *T. gondii* IgG-Abs, while 38 (38.78%) were in the healthy control group [22].

In Iran, a study done by Shirbazou et al. reported the prevalence of toxoplasma infection in diabetic and healthy persons was 60.43% and 38%, respectively, but also, in another study, the seropositivity was 70.3% [15, 23]. The seropositivity for toxoplasma IgG infection in diabetic patients was 56% [24]. According to a study conducted by Li et al., 19.25% of T2DM patients tested positive for *T. gondii* IgG antibodies, compared to 9.25% of the control groups [25], while Han et al. recorded that the prevalence of *T. gondii* in diabetic patients was 9.56% [21]. In India it was 73.5% [26] and in the USA it was 10.8% [27]. According to the results in diabetic patients, 45.8% of females and 44.8% of males were positive for anti *T. gondii* IgG. The results showed that diabetic patients >60 years old had the highest rate of seropositive *T. gondii* infections (40.23%), while those ≤30 years old had the lowest rate (4.60%) with the mean of T2DM patients is 7.15 ± 1.94. The majority of the participants in this study are elderly patients over the age of 60 years with a rate of 39.6%. In the United States, a study was conducted that showed that the seroprevalence rate of *T. gondii* in 12-49 years of age was 14.1% in NHANES III (1988-1994) to 9.0% in NHANES 1999-2004 to 6.7% in NHANES 2009-2010 [28]. Urban residents had a somewhat greater prevalence of Anti-*Toxoplasma gondii* IgG positive than rural residents did (58.3% vs. 32.3%). Li et al. mentioned that the seroprevalence of *T. gondii* infection among T2DM patients living in urban areas was

higher than among those who lived in rural areas, 25% and 22%, respectively [25].

Globally, the incidence of toxoplasmosis and diabetes is very high. Toxoplasmosis infection leads to damage to the pancreas, β -cell neurons, and tissue necrosis in the pancreas, and in acute infections, insulin levels will be affected, and the pancreas may secrete too much insulin in patients, which means that this infection is one of the possible causes of chronic pancreatitis [29,30]. Prior studies hypothesized that there is a potential correlation between toxoplasmosis and susceptibility to diabetes, as these patients are more vulnerable to opportunistic infections [15,24,30,31]. Also, toxoplasmosis occurs in immunocompromised and HIV/AIDS patients and is most frequently found in brain lesions, coma, and death [32-34]. There is a lot of evidence indicating there is an expected link between *T. gondii* infection and T2DM patients, which explains how *T. gondii* contributes to the increased vulnerability to T2DM; this association is expected because T2DM patients

are susceptible to many opportunistic diseases. One of the most significant risk factors for *T. gondii* infection in diabetic patients is having cats in the house and other risk factors include eating raw or undercooked meat that includes tissue cysts and drinking water that has been contaminated with *T. gondii* eggs [35,36].

CONCLUSIONS

The current study revealed a high prevalence of *T. gondii* IgG among T2DM patients at 90.63%. The rate of seropositivity for *T. gondii* IgG among patients living in urban areas was slightly higher in incidence than in those in rural areas. The results showed that diabetic patients >60 years old had the highest rate, while those \leq 30 years old had the lowest rate.

Conflicts of interest: There are no significant conflicts of interest among the authors relevant to this research subject
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