BENHA MEDICAL JOURNAL bmj

Print ISSN 1110-208X.

Online ISSN 2357-0016

Seroprevalence of Toxoplasma Gondii among Hemodialysis Patients in Qalyubia Governorate, Egypt

Atef H. Hussein[a] , Nagwa S. Aly[a], Gehan A. Rashed[a], Enas M. Mohamed Ali[b], Fatma S. Ibrahim[a], Doaa I. Mohamed[a]

[a] Medical Parasitology Department, Faculty of Medicine Benha University, Egypt.

[b] Internal Medicine Department, Faculty of Medicine Benha University, Egypt.

Corresponding to:
Dr. Fatma S. Ibrahim.
Medical Parasitology Department, Faculty of Medicine Benha University, Egypt.
Email: fatmasabry857@gmail.com

Received:
Accepted:

Abstract:

Background: Hemodialysis patients are regarded as immuno-compromised. Therefore, these are more susceptible to opportunistic infections like Toxoplasma gondii (T. gondii). This study aimed to detect T. gondii infection seroprevalence in hemodialysis patients in Qalyubia Governorate, Egypt. **Methods:** This observational, comparative cross-sectional study included 150 participants: 100 patients undergoing hemodialysis and 50 healthy control subjects in hemodialysis units located in Qalyubia Governorate. **Results:** Logistic regression analysis revealed that patients undergoing hemodialysis had significantly higher odds of IgG seropositivity compared to the control group, with an adjusted odds ratio (aOR) of 3.09 (95% CI: 1.47–6.48, P<0.05). None of the other examined sociodemographic or behavioral factors including sex, age, education level, urban residence, cats contact, or undercooked meat eating was significantly associated with IgG seropositivity. **Conclusion:** Positive anti-Toxoplasma IgG prevalence was significantly higher in hemodialysis patients (65%) compared to healthy controls (36%) (P < 0.05). This suggests that latent or past T. gondii infection is more common among hemodialysis patients. Therefore, regular screening for T. gondii infection should be included as part of the routine clinical care for hemodialysis patients.

Keywords: Seroprevalence; Toxoplasma gondii; Hemodialysis; Qalyubia.

Introduction

Toxoplasma gondii (T. gondii) is a common intracellular parasite that is widely distributed across all continents and has the potential to infect humans and approximately all warm-blooded vertebrates [1]. *T. gondii* infection spreads by consuming of oocyst-contaminated food or water, uncooked undercooked meat contaminated with tissue cysts, vertical transmission from mother to fetus, and a rare occurrence of organ transplantation and blood transfusion [2].

This parasite is believed to infect approximately one-third of the global human population [3]. Anti-*toxoplasma* IgG seroprevalence varied from 3% to 42.5% in Egypt [4]. Although toxoplasmosis is asymptomatic and chronic in immunocompetent individuals, it can lead to life-threatening outcomes in at-risk individuals, including expectant women and immunocompromised individuals, including hemodialysis patients [5].

Typically, patients undergoing hemodialysis experience the retention of uremic contaminants in their bloodwork. These toxins augment the susceptibility of individuals to infections by disrupting humoral and cellular immunity functions [6]. Patients undergoing hemodialysis are immunocompromised [7]. Therefore, they are more susceptible to opportunistic pathogens, including *T. gondii* [8].

Chronic kidney diseases affect 10% of the global population, with 2.6 million individuals undergoing hemodialysis. This figure is expected to increase to approximately 5.4 million by 2030 [9]. The total prevalence of patients on dialysis is 264 per million individuals, and the estimated annual incidence of end-stage kidney disease (ESKD) in Egypt is approximately 74 per million [10]. Overall, research indicates that hemodialysis patients have a significantly increased *T. gondii* antibodies (IgG and sometimes IgM) seroprevalence compared to healthy controls.

The purpose of this study was to evaluate *T. gondii* infection seroprevalence among patient undergoing hemodialysis in Qalyubia Governorate, Egypt using Electrochemiluminescence immunoassay (ECLIA).

Patients and methods

This observational, comparative cross-sectional study involved 150 participants, including 100 patients undergoing regular hemodialysis for chronic kidney disease and 50 healthy volunteers. The study took place at the hemodialysis units in Qalyubia Governorate, Egypt, from September 2024 to September 2025.

The patients provided written informed consent. Every patient received an explanation of the purpose of the study and had a private code number. The study was done after being approved by the Research Ethics Committee, Faculty of Medicine, Benha University.

Inclusion criteria in case group: the patients undergoing regular hemodialysis for chronic kidney disease, in the control group: Healthy participants who have normal blood urea nitrogen and creatinine levels and no renal illness agree to take part in the trial after providing written informed consent.

Exclusion criteria in case group were cases with depressed immunity like diabetes mellitus, malignancies, or those on immunosuppressive drugs. In the control group patients with history of renal or chronic debilitating disease in control group.

Grouping: Cases were divided into 2 groups: **Group I (n=100)**: patients undergoing hemodialysis and **group II (n=50):** control subjects.

All people were subjected to the following: Full history taking (Demographic data: age, gender, residence, occupation, education level, hemodialysis treatment duration, contact with cats or handling cat litter, raw or undercooked meat consumption).

Blood sampling and preparation:

5 ml of venous blood was drawn from every patient using a sterile vacutainer system. Samples were centrifuged at a relative centrifugal force of 1700 × g for five minutes to separate the serum, which was then stored at –20°C until analysis [11].

Serological testing of anti-*Toxoplasma* IgG

Quantitative Electrochemiluminescence Immunoassay (ECLIA) was done using Elecsys anti-*toxoplasma* IgG test by Roche Diagnostics (Cobas e 411 and Elecsys 2010). The quantitative sandwich test is based on the recombinant surface antigen SAG1 (p30). In summary, the test lasted for 18 minutes and utilized a sample volume of 10 µl. The sample was incubated with biotinylated recombinant *T. gondii*-specific antigen and *T. gondii*-specific recombinant antigen labeled with a ruthenium complex, and then with streptavidin-coated microparticles. The chemiluminescent emission that resulted was then measured by a photomultiplier, and unbound substances were removed through magnetic capture. The 3rd International Standard (TOXM NIBSC, UK) was used to standardize a calibration curve, which was used to determine the results. Results between 1 and 2.9 IU/ml were deemed indeterminate, with a cut-off value of 3 IU/ml [18].

Approval code: (MS 18-4-2024) Research Ethics Committee, Faculty of Medicine, Benha University.

Statistical analysis:

Analysis conducted using SPSS Statistics version 25. Mean ± SD is used to represent quantitative data, whereas frequency and percentages are used to represent qualitative data. Statistical significance is indicated by p < 0.05, while highly significant is denoted by p < 0.001. Kruskal-Wallis test [12], Fisher's exact test or Chi-square test [13], Trend test [14], and logistic regression were used where appropriate [15].

Results

Table 1 shows the comparative seroprevalence and IgG antibody levels against *T. Gondii* in hemodialysis patients versus healthy controls. Positive anti-*Toxoplasma* IgG prevalence was significantly higher among hemodialysis patients (65%) than controls (36%) (P <0.05). Median IgG levels among seropositive individuals were similar between both groups [313.1 (106.4–473.7) vs. 302.0 (118.7–415.0), P >0.05]. Proportion of equivocal results was significantly lower in hemodialysis group (26%) versus controls (48%) (P<0.5), while negative results were not significantly different (P>0.05). Within each group, Kruskal-Wallis tests indicated highly significant differences in IgG levels across serological categories (P > 0.001 for hemodialysis group, P >0.001for controls). These findings indicate an increased latent or past *T. gondii* infection seroprevalence among hemodialysis patients. However, the level of anti-toxoplasma IgG was indifferent among seropositive individuals in hemodialysis group and healthy controls.

Table 2 shows comparison of anti-*Toxoplasma* IgG serology results of hemodialysis group and controls across various demographic data. Comparison of anti-*Toxoplasma* IgG serology results between hemodialysis patients and controls revealed no significant impact from sex, residence, or overall education level on serological status within or between groups. However, a significantly higher proportion of seropositive cases were noted among hemodialysis patients aged 20–29 and 30–39 years compared to controls. Additionally, individuals with intermediate education in the hemodialysis group showed a markedly greater seropositivity rate versus their counterparts (P < 0.05), though education did not significantly affect serology distribution within either group.

Table 3 shows no statistically significant association between contact with cats and

IgG serology results in either groups (P > 0.05).Within both groups, contact with cats was not significantly related to serology results (haemodialysis: P = 0.44, controls: P = 0.22).Similarly, no significant differences were found in serology results according to the consumption of undercooked meat within the haemodialysis group (P = 0.13) or controls (P = 0.37).

Table 4 shows logistic regression analysis revealed that patients undergoing hemodialysis had significantly higher odds of IgG seropositivity compared to the control group, with an adjusted odds ratio (aOR) of 3.09 (95% CI: 1.47–6.48, P<0.05). None of the other examined sociodemographic or behavioral factors—including sex, age, education level, urban residence, contact with cats, or undercooked meat eating was significantly associated with IgG seropositivity.

Table 5 shows the relationship between the duration of haemodialysis and the positivity rate of anti-*toxoplasma* IgG antibodies. Percentage of IgG-positive patients was comparable across all duration categories, with no consistent increase or decrease observed as the duration increased. Statistical analysis using the Chi-square test indicated no significant differences between the groups (P>0.05). Additionally, trend test showed no significant linear trend in IgG positivity with increasing duration of haemodialysis (P>0.05). This indicates that duration of haemodialysis does not appear to affect the likelihood of having anti-*toxoplasma* IgG antibodies.

Table 6 shows were no statistically significant differences in urea or creatinine (P >0.05) levels between the anti-*Toxoplasma* IgG serostatus groups. Similarly, in the control group, urea and creatinine values remained within normal ranges and did not differ significantly across IgG status categories (urea or creatinine P>0.05). These findings indicate anti-toxoplasma IgG serostatus is not associated with variations in urea or creatinine levels in haemodialysis patients or controls, suggesting that kidney function markers were not correlated with IgG seropositivity in this study.

Table 7 shows no statistically significant associations were found between anti-*Toxoplasma* IgG status and the presence of cardiac disease (P>0.05), hypertension (P>0.05), or the absence of chronic diseases (P>0.05). However, there was a significant association between liver disease and anti-Toxoplasma IgG status (P<0.05, Fisher's exact test), where anti-*Toxoplasma* seropositivity was lower among patients with liver disease (33.3%) compared to those without liver disease (67.0%).

Table 1: Comparative Seroprevalence of anti-toxoplasma IgG antibodies in hemodialysis patients and controls using chemilumenscence ELISA

Serology result	**Hemodialysis group**		**Control group**		**% positivity P-value**	**Mean IgG level P- value**
	No. (%) of positive	**IgG Level Median [IQR]**	**No. (%) of positive**	**IgG Level Median [IQR]**		
Positive	65(65%)	313.1 [106.4–473.7]	18(36%)	302.0 [118.7–415.0]	**P<0.05***	**P >0.05**
Negative	9(9%)	0.875(0.227-0.986)	8(16%)	0.678(0.352-0.957)	**P>0.05**	**P>0.05**
Equivocal	26(26%)	1.324(1.121-1.542)	24(48%)	1.365(1.125-1.1.542)	**P<0.05**	**P>0.05**
	P<0.001**		**P>0.001**			

Table 2: Impact of sociodemographic criteria on anti-*toxoplasma* igg seropositivity in individuals undergoing hemodialysis

		Hemodialysis group (n= 100)				Control Group (n= 50)				P-value
		No. of ~~cases~~	**Negative**	**Positive**	**Equivocal**	**No. of cases**	**Negative**	**Positive**	**Equivocal**	
Sex	**Male**	**62**	4(6.5%)	42(67.7%)	16(25.8%)	**26**	3(11.5%)	11(42.3%)	12(46.2%)	**P>0.05**
	Female	**38**	4(10.5%)	23(60.5%)	11(28.9%)	**24**	5(20.8%)	7(29.2%)	12(50%)	**P>0.05**
				P>0.05**				P>0.05		
Age	**20-29**	**9**	1(11.7)	8(88.9%)	0 (0.0%)	**10**	1(10.0%)	4(40.0%)	5(50.0%)	**P>0.05**
	30-39	**20**	1(5.0%)	14(70.0%)	5(25.0%)	**11**	1(9.1%)	2(18.2%)	5(72.7%)	**P>0.05**
	40-49	**35**	3(8.6%)	20(57.1%)	12(34.3%)	**8**	1(12.5%)	5(62.5%)	2(25.0%)	**P>0.05**
	50-59	**30**	2(6.7%)	22(73.3%)	6(20.0%)	**5**	2(40.0%)	1(20.0%)	2(40.0%)	**P>0.05**
	≥60	**6**	1(16.7%)	2(33.3%)	3(50.0%)	**16**	3(18.8%)	6(37.5%)	7(43.8.0%)	**P>0.05**
				P>0.05				P>0.05		
Education	**No education**	**37**	5(13.5%)	19(51.4%)	13(35.1%)	**0**	0(0.0%)	0(0.0%)	0(0.0%)	**P>0.05**
	Low education	**7**	0(0.00%)	6(85.7%)	1(14.3%)	**1**	1(100.0%)	0(0.0%)	0(0.0%)	**P>0.05**
	Intermediate education	**44**	2(4.5%)	34(77.3%)	8(18.2%)	**13**	2(15.4%)	2(15.4%)	9(69.2%)	**P<0.05**
	High education	**12**	1(8.3%)	6(50.0%)	5(41.7%)	**36**	5 (13.9%)	16(44.4%)	15(41.7%)	**P>0.05**
				P>0.05				**P>0.05**		
Address	**Urban**	**62**	5(8.1%)	43(69.4%)	14(22.6%)	**38**	7(18.4%)	12(31.6%)	19(50.0%)	**P<0.05**
	Rural	**38**	4(10.5%)	22(57.9%)	12(31.6%)	**12**	1(8.3%)	6(50.0%)	5(41.7%)	P>**0.05**

Data was presented as frequency (%). P-values were calculated using the Chi-square test or Fisher's exact test, as appropriate. P < 0.05 was considered statistically significant

Table 3: Impact of behavior and habits (contact with cats and eating undercooked meat) on Anti-*Toxoplasma* IgG Seropositivity in Individuals Undergoing Hemodialysis

		Hemodialysis group (n= 100)				Control Group (n= 50)				P-value
		No. of cases	**Negative**	**Positive**	**Equivocal**	**No. of cases**	**Negative**	**Positive**	**Equivocal**	
Contact with cats	**Yes**	4	1(25.0%)	2(50.0%)	1(25.0%)	3	1(33.3%)	2(66.7%)	0(00%)	**P**>0.05
	No	96	8(8.3%)	63(65.6%)	25(26.1%)	47	7(14.9%)	16(34.0%)	24(51.1%)	
				P>0.05				**P>0.05**		
Eating underc ooked meat	**Yes**	35	2(5.7%)	27(77.1%)	6(17.1%)	12	1(8.3%)	7(58.3%)	4(33.3%)	**P>0.05**
	No	65	7(10.8%)	38(58.5%)	20(30.8%)	22	7(18.4%)	11(28.9%)	20(52.6%)	
				P>0.05				**P>0.05**		

Data was presented as frequency (%). *P < 0.05 was considered statistically significant. *P-values were calculated using the Chi-square test or Fisher's exact test, as appropriate.

Table 4: Logistic regression analysis of sociodemographic and risk factors vs IgG seropositivity

Predictor	cOR (95% CI)	cOR P-value	aOR (95% CI)	aOR P-value
Haemodialysis group vs control	3.30 (1.62–6.71)	P<0.05	3.09 (1.47–6.48)	P<0.05
Sex (Male)	1.09(0.62-1.91)	P>0.05	1.12(0.61-2.07)	P>0.05
Age (per year)	1.01(0.98-1.04)	P>0.05	1.01(0.98-1.04)	P>0.05
Education Level	0.92(0.68-1.33)	P>0.05	0.95(0.68-1.33)	P>0.05
Urban Address	1.22(0.69-2.15)	P>0.05	1.19(0.63-2.26)	P>0.05
Contact with Cats	0.79(0.25-2.46)	P>0.05	0.82(0.24-2.86)	P>0.05
Eating Undercooked Meat	1.117(0.64-2.13)	P>0.05	1.13(0.559-2.17)	P>0.05

Data was presented as number. cOR (Crude Odds Ratio): The odds ratio calculated without adjusting for other variables, representing the direct association between each predictor and IgG seropositivity. aOR (Adjusted Odds Ratio): The odds ratio after adjusting for potential confounding variables, reflecting the independent effect of each predictor on IgG seropositivity. P-value less than 0.05 indicates statistically significant.

Table 5: The relation between anti-*toxoplasma* IgG positivity and Duration of hemodialysis

Duration (years)	n	IgG Positive n (%)	Chi-square (p-value) for difference between groups	Trend Test (p-value) for trend across ordered groups
≤2	12	8 (66.7%)	**P>0.05**	**P>0.05**
3–5	17	10(58.8%)		
6–10	27	19(70.4%)		
>10	44	28(63.6%)		

Data was presented as frequency (%). *P>0.05 shows not statistically significant. *P-values were calculated using the Chi-square comparing IgG positivity proportions across groups. P>0.05 shows not statistically significant by Trend Test for linear trend across ordered duration gro

Table 6: The relation between urea and creatinine level and anti-*toxoplasma* IgG seropositivity

IgG Result	Hemodialysis group (n= 100)	Urea Median [IQR] (mg/dl)	Creatinine Median [IQR] (mg/dl)	Control Group (n= 50)	Urea Median [IQR] (mg/dl)	Creatinine Median [IQR] (mg/dl)
Positive	65	129(98-148)	9.2(7.4-11.2)	18	25(18-32)	0.8(0.7-0.1)
Equivocal	26	130(115-153)	9.7(8.5-11.0)	24	25(19-29)	0.8(0.7-0.9)
Negative	9	120(98-146)	9.5(8.3-10.0)	8	23(21-28)	0.7(0.6-0.8)
--	--	**P >0.05**	**P>0.05**	--	**P >0.05**	**P>0.05**

Data was presented as median or number. P>0.05 is not statistically significant, Kruskal-Wallis test within each group.

Table 7: The relation between *Toxoplasma* seropositivity among hemodialysis patients and some associated chronic systemic diseases

Associated chronic diseases		Total patient no. (n= 100)	Toxoplasma positivity	Toxoplasma seronegative	Toxoplasma equivocal	P value
Cardiac disease	**Yes**	46(46.0%)	29(.63.0%)	5 (10.9%)	12 (26.1%)	**P>0.05**
	no	54 (54.0%)	36 (66.7%)	3 (5.6%)	(.27.8%) 15	
Hypertension	**Yes**	81(81.0%)	56(69.1%)	5(6.2%)	20 (24.7%)	
	no	19 (19.0%)	9 (47.4%)	3 (15.8%)	7 (36.8%)	
Liver disease	**Yes**	6(6.0%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	
	no	94 (94.0%)	63 (67.0%)	6 (6.4%)	25 (26.6%)	
No chronic diseases		11 (11.0%)	5 (45.5%)	2 (18.2%)	4 (36.4%)	

*Data was presented as frequency (%). P-values were calculated using the Chi-square test or Fisher's exact test, as appropriate. *P < 0.05 was considered statistically significant*

Discussion

The current investigation, we investigated anti-*T. gondii* IgG antibodies seroprevalence among patients undergoing hemodialysis in comparison to a healthy control group. The findings revealed that 65% of the hemodialysis patients tested positive for *T. gondii* IgG antibodies, whereas only 36% of the individuals in the control group showed seropositivity. This indicates a notably higher *T. gondii* infection prevalence among hemodialysis patients than healthy subjects.

In line with our results, Hamza et al [16] found a similar prevalence of 61.7% among HDP in Alexandria, Egypt. El-Tantawy et al. [17], also reported that anti-*Toxoplasma gondii* IgG antibodies seropositivity in Mansoura hospital was significantly increased in HD patients 66.7% (28/42) compared to 34% in controls (17/50), (p = 0.0003). Salem et al., [18] reported that in Mansoura University hospital, in overall, In 28 (66.7%) HD patients and 17 (34%) controls, anti-*Toxoplasma gondii* IgG antibodies were detected. HD patients had significantly higher positive anti-*Toxoplasma gondii* IgG and anti-*Toxoplasma gondii* IgG titter mean values than controls (p = 0.0003, < 0.001 respectively). Moreover, Saad et al. [19] showed that at National Liver Center in Egypt, seroprevalence rate in immunocompromised group was 50%, which was also higher than the seroprevalence rate in immunocompetent group of 32%. The difference was statistically significant (P=0.01).

However, this prevalence is greater than what Sharaf et al. [20] reported, who found that 22% of hemodialysis patients in Cairo, Egypt had *T. gondii* seropositivity and that of Moawad et al. [21], who reported a seroprevalence of (23%) between children receiving hemodialysis at Zagazig University Pediatrics Hospital, Egypt.

Conversely**,** Kadkhodaei et al. **[22],** in southern Iran found higher seropositivity among patients (18.66% and 25.33%) compared to controls (13.33%), but these differences were not statistically significant, likely due to regional, sample size, or local prevalence variations highlighting the role of factors beyond immune status in infection rates.

The higher *T. gondii* IgG antibodies seroprevalence in hemodialysis patients than healthy controls are due to their compromised immune system caused by chronic renal failure and immunosuppressive treatments. This impairs T-cell function, which is crucial for controlling intracellular pathogens like *T. gondii*. While immunocompetent individuals can usually suppress or clear the infection, weakened immunity in these patients allows the parasite to persist or reactivate. The presence of IgG antibodies indicates past exposure and a humoral response but also suggests an inability to fully eliminate the infection, increasing the risk of chronic or reactivated toxoplasmosis in hemodialysis patients [17, 23, 24].

Our study shows no statistically significant association was found between sex and anti-*T. gondii* IgG seropositivity in either the hemodialysis or control groups (P > 0.05). Although both male and female hemodialysis patients exhibited higher seropositivity rates compared to their respective controls, the differences were not statistically significant. This is in accordance with other studies that found no correlation between sex and the rate of *T. gondii* infections reported by Kadkhodaei et al. **[22]**, Soltani et al. **[25],** and Saki et al. [26]**.** However, both Hussein and Molan [27] , who conducted a study in Diyala Province, Iraq, and El-Tantawy et al. [17], who carried out a study in Saudi Arabia and Egypt, reported a significantly higher IgG seropositivity rate among male patients compared to females, suggesting that male sex may be a potential risk factor for *T. gondii* infection due to behavioral exposures such as increased contact with cats or consumption of undercooked meat; with Hussein and Molan [27] observing an overall seropositivity of 54.1% in patients versus 38.2% in controls (P = 0.0465), and El-Tantawy reporting 57.31% in the hemodialysis group compared to 22% in controls. The conflicting findings across studies may be attributed to differences in geographic regions, lifestyle habits, or sample size variations. While most studies including the present one do not consistently support a sex-based disparity in susceptibility to *T. gondii*, the significant associations observed in certain populations highlight the need for further investigation to clarify the potential role of gender in toxoplasmosis risk.

In the current study, no significant association was found between age and anti *T. gondii* IgG seropositivity in either hemodialysis or control groups. This agreed with Soltani et al. [25], who conducted the study in Iran and also found age to be a non-significant factor. However, El-Tantawy et al. [17], whose study was carried out in Egypt, reported a significant relation between age and *T. gondii*, showing higher IgG rates in older individuals, suggesting cumulative exposure over time. This contrasting evidence in literature, especially among older or immunocompromised populations, highlights the need for further age-stratified research.

In the current study, we found that there is no statistically significant association between education level and anti-*Toxoplasma* IgG seropositivity in hemodialysis group. However, controls, individuals with intermediate education showed a statistically significant difference in seropositivity ($P < 0.05$).

Similarly, Salem et al. [18] in Iraq found no significant difference across education levels, despite slightly higher rates in those with 6–12 years of education. Conflicting findings were observed by Elgodwi and Mohamed [28] in Libya and El-Tantawy et al. in Egypt **[17]**, who both reported higher seroprevalence among individuals with lower education, linking it to poor hygiene and risky practices like contact with cats and eating undercooked meat. These results may reflect regional differences in education, culture, and access to health information.

The current study found a statistically significant link between place of residence and *T. gondii* IgG seropositivity among hemodialysis patients, with urban residents showing higher rates (69.4%) than rural ones (31.6%). This challenges the common belief that rural populations are more at risk due to environmental exposure. This partially aligns with Soltani et al. **[25]**, who found no significant difference between urban and rural residents, suggesting lifestyle and hygiene may be more influential. In contrast, Lima et al. [29] in Brazil and Hamidi et al. [30] in Iran reported higher seroprevalence in rural areas, attributing it to environmental factors like contact with contaminated soil and untreated water. However, Salem et al., [18] reported that residency in Iraq was comparable between two groups. Also, Moawad et al., [31] reported that there was statistically insignificant difference between hemodialysis and control groups regarding the residence (as a possible risk factor for toxoplasmosis) at Zagazig University Pediatrics Hospital, Egypt. These conflicting findings may reflect regional differences in infrastructure, sanitation, and food safety. Urban risks may stem from overcrowding and poor waste management, while rural risks are linked to farming and animal contact. Thus, both environments pose distinct but significant risks depending on local conditions.

In the current study, although a higher percentage of seropositive cases was noted among individuals who reported contact with cats or undercooked meat, especially within the hemodialysis group, no statistically significant association was found ($P > 0.05$). These findings are partially consistent with Soltani et al. [25], who also found no significant link between cat contact and seropositivity, suggesting that lifestyle and hygiene may play a more critical role. However, other studies like El-Tantawy et al. [17] and Hamidi et al. (30) reported significant associations with both risk factors, especially in populations with lower education levels or poor sanitation. Similarly, Lima et al. [29] emphasized undercooked meat as a major transmission route in endemic areas. The conflicting evidence across studies may reflect regional differences in exposure, food safety practices, and sample sizes. While the current study did not establish statistical significance, the observed trends and supporting literature suggest that both cat contact and dietary habits remain important considerations in toxoplasmosis risk, particularly among immunocompromised individuals.

The logistic regression analysis revealed that being in the hemodialysis group was the only statistically significant predictor of anti *T. gondii* IgG seropositivity, with both the crude odds ratio (cOR = 3.30, 95% CI: 1.62–6.71) and adjusted odds ratio (aOR = 3.09, 95% CI: 1.47–6.48) indicating a significantly higher risk compared to the control group. This finding is consistent with multiple studies, such as El-Tantawy et al. [17] and Hamidi et al. **[30]**, which reported increased susceptibility to toxoplasmosis among immunocompromised individuals, including those undergoing hemodialysis, due to impaired immune responses.

In contrast, sex, age, education level, urban residence, contact with cats, and eating undercooked meat were not significantly related to seropositivity in either the crude or adjusted models (P > 0.05). These results suggest that, within this study population, these sociodemographic and behavioral factors did not independently predict infection risk. However, this contrasts with findings reported in some other studies, such as Lima et al. (29) and Hamidi et al. (30), who found that eating undercooked meat was a significant risk factor, especially in rural and low-income populations. Also, Elgodwi & Mohamed (28) and El-Tantawy et al. (17) who reported that lower education levels and contact with cats were significantly associated with higher seroprevalence, likely due to reduced awareness of transmission routes and poor hygiene practices. A meta-analysis by Foroutan-Rad et al. (32) also identified age and rural residence as significant predictors in some populations, though results varied by region and study design. These discrepancies may be attributed to differences in sample size, geographic location, cultural practices, and the presence of confounding variables. The lack of significance in the current study could also reflect limited statistical power or homogeneity in exposure patterns among participants.

In the current study, no statistically significant association was found between the duration of hemodialysis and anti *T. gondii* IgG seropositivity (P > 0.05 for both Chi-square and trend tests). Although seropositivity rates varied slightly across duration groups — ranging from 58.8% to 70.4%, these differences were not statistically meaningful, suggesting that duration alone may not be a strong independent predictor of infection risk. This result aligns with findings from Soltani et al. (25), who reported no significant correlation between dialysis duration and *T. gondii* seropositivity among patients in Iran, emphasizing that other factors such as immune status and environmental exposure may be more influential. However, conflicting evidence comes from El-Tantawy et al. (17) and Hamidi et al. **(30)**, both of whom reported a positive association between longer duration of dialysis and higher *T. gondii* IgG seropositivity, suggesting that cumulative exposure and prolonged immunosuppression may increase infection risk over time. These discrepancies may be explained by differences in study design, sample size, geographic location, and patient characteristics. For example, variations in water treatment, food safety, and hygiene practices across regions could influence exposure risk independently of dialysis duration. This inconsistency highlights the need for further longitudinal and multicenter studies to clarify whether duration contributes to cumulative risk, especially in settings with high environmental exposure or limited infection control measures.

Salem et al., (33) reported that approximately 44.0% of hemodialysis patients had positive serum IgG antibodies and 1.33% had positive IgM antibodies against *T. gondii* by ELISA. In comparison, among healthy subjects, IgG and IgM positivity rates were about 4.0% and 0%, respectively. IgG positivity generally indicates a chronic or past infection that usually persists for life, while IgM positivity reflects an acute or recent infection, appearing earlier and declining faster than IgG antibodies (34).

The current study shows that urea and creatinine levels did not differ significantly between anti-*Toxoplasma* IgG seropositive and seronegative groups in both hemodialysis patients and healthy controls (P > 0.05). This suggests no detectable correlation between *Toxoplasma* IgG seropositivity and traditional serum markers of kidney function in these populations. In contrast, Abood et al. (35) reported that among a cohort of hemodialysis patients in Baghdad, urea levels were significantly higher in *Toxoplasma* IgG-positive individuals, while serum creatinine levels did not differ significantly by serostatus. Al-Khafaji et al., [36] reported that among a cohort of hemodialysis patients in Baghdad, urea levels were significantly higher in *Toxoplasma IgG*-positive individuals, while serum creatinine levels did not differ significantly by serostatus. Also, Rahimi et al. [37] analyzing data from the Mazandaran CKD Registry, observed a significant association between IgG seropositivity and lower estimated glomerular filtration rate (eGFR), suggesting more advanced CKD stages in seropositive individuals, although serum creatinine and urea were not directly reported. The discrepancies observed across studies highlight the need for further large-scale, multicenter investigations incorporating broader renal function parameters such as eGFR, proteinuria, and inflammatory markers to better elucidate the clinical relevance of *T. gondii* infection in patients with hemodialysis patients.

In present investigation, shows no statistically significant associations were found between anti-*Toxoplasma* IgG status and the presence of cardiac disease (P>0.05), hypertension (P>0.05), or the absence of chronic diseases (P>0.05). However, there was a significant association between liver disease and anti-*Toxoplasma* IgG status (P<0.05, Fisher's exact test), where anti-*Toxoplasma* seropositivity was lower among patients with liver disease (33.3%) compared to those without liver disease (67.0%). However, El-Tantawy et al. **[17]** and Hamidi et al. [30] reported that chronic systemic diseases, particularly liver disease, may influence immune function and increase susceptibility to *T. gondii* infection. These studies suggest that immunocompromised states, including those caused by liver dysfunction, may alter serological responses and infection risk. In contrast, Alvarado-Esquivel et al. [38] and Soltani et al. [25] found no significant association between *T. gondii* seropositivity and comorbidities such as cardiac disease or hypertension in renal patients. These studies argue that while hemodialysis patients are at higher risk overall, specific chronic conditions may not independently predict infection.

The current study aligns with the latter group of findings, showing no significant association between *T. gondii* seropositivity and cardiac disease or hypertension, but a potential link with liver disease. These mixed results across studies highlight the need for more targeted research to clarify how different chronic conditions may influence toxoplasmosis risk in immuno-compromised populations.

Conclusion

Positive anti-*Toxoplasma* IgG prevalence was significantly higher in hemodialysis patients (65%) compared to healthy controls (36%) (P < 0.05). This suggests that latent or past *T. gondii* infection is more common among hemodialysis patients. Consequently, it is imperative that hemodialysis patients undergo routine clinical evaluation for *T. gondii* infection.

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

Conflicts of interest

No conflicts of interest

References

1. Sanchez SG, Besteiro S. The pathogenicity and virulence of *Toxoplasma gondii*. Virulence. 2021;12:3095-114.
2. Wang Z-D, Liu H-H, Ma Z-X, Ma H-Y, Li Z-Y, Yang Z-B, et al. *Toxoplasma gondii* infection in immunocompromised patients: a systematic review and meta-analysis. Front Microbiol. 2017;8:389-98.
3. Rostami A, Riahi SM, Gamble HR, Fakhri Y, Nourollahpour Shiadeh M, Danesh M, et al. Global prevalence of latent toxoplasmosis in pregnant women: a systematic review and meta-analysis. Clin Microbiol Infect. 2020;26:673-83.
4. Taman A, Alhusseiny S. Exposure to toxoplasmosis among the Egyptian population: A systematic review. Parasitol United J. 2020;13:1-10.
5. Fallahi S, Rostami A, Nourollahpour Shiadeh M, Behniafar H, Paktinat S. An updated literature review on maternal-fetal and reproductive disorders

of *Toxoplasma gondii* infection. J Gynecol Obstet Hum Reprod. 2018;47:133-40.
6. Altamura S, Pietropaoli D, Lombardi F, Del Pinto R, Ferri C. An Overview of Chronic Kidney Disease Pathophysiology: The Impact of Gut Dysbiosis and Oral Disease. Biomedicines. 2023;11:34-76.
7. Omrani VF, Fallahi S, Rostami A, Siyadatpanah A, Barzgarpour G, Mehravar S, et al. Prevalence of intestinal parasite infections and associated clinical symptoms among patients with end-stage renal disease undergoing hemodialysis. Infection. 2015;43:537-44.
8. Kato S, Chmielewski M, Honda H, Pecoits-Filho R, Matsuo S, Yuzawa Y, et al. Aspects of immune dysfunction in end-stage renal disease. Clin J Am Soc Nephrol. 2008;3:1526-633.
9. Liyanage T, Ninomiya T, Jha V, Neal B, Patrice HM, Okpechi I, et al. Worldwide access to treatment for end-stage kidney disease: a systematic review. Lancet. 2015;385:1975-82.
10. Barsoum RS. Overview: end-stage renal disease in the developing world. Artif Organs. 2002;26:737-46.
11. Soltani S, Foroutan M, Afshari H, Hezarian M, Kahvaz MS. Seroepidemiological evaluation of *Toxoplasma gondii* immunity among the general population in southwest of Iran. J Parasit Dis. 2018;42:636-42.
12. Chicco D, Sichenze A, Jurman G. A simple guide to the use of Student's t-test, Mann-Whitney U test, Chi-squared test, and Kruskal-Wallis test in biostatistics. BioData Min. 2025;18:56.
13. Kim HY. Statistical notes for clinical researchers: Chi-squared test and Fisher's exact test. Restor Dent Endod. 2017;42:152-5.
14. Schaarschmidt F, Ritz C, Hothorn LA. The Tukey trend test: Multiplicity adjustment using multiple marginal models. Biometrics. 2022;78:789-97.
15. Zabor EC, Reddy CA, Tendulkar RD, Patil S. Logistic Regression in Clinical Studies. Int J Radiat Oncol Biol Phys. 2022;112:271-7.
16. Hamza H, El-Taweel H, Abou-Holw S, Khalil S, Wagdy E. *Toxoplasma gondii* seropositivity in renal patients: rate, pattern, predictors and related morbidity. J Egypt Soc Parasitol. 2015;45:7-15.
17. El-Tantawy NL. Toxoplasmosis Seroprevalence among Hemodialysis Patients: A Case-Control Study. Egyptian Academic Journal of Biological Sciences, E Medical Entomology & Parasitology. 2024;16:21-7.
18. Salem MS, Shaker MJ, Mohammed NK. Impact of toxoplasmosis in im-mune respons in hemodialysis patients. Diyala J Med. 2022;22:1-11.
19. Saad A-GE, Sharaf SA, Selim SM, Ibrahim TM, Yassein YS, Mohsen KK, et al. Role of IgG avidity test in diagnosis of Toxoplasmosis among immunocompromised patients. Egyptian Journal of Medical Microbiology. 2020;29:25-31.
20. Sharaf M, Ashkar A, Omran E, Elhakim I. Prevalence of Parasitic Infections and Related Morbidity in Pediatric Patients on Regular Hemodialysis in Ain Shams University Pediatric Hospital, Cairo, Egypt. J Infect Enem Dis. 2021:7-12.
21. Moawad H, Etewa S, Mohammad S, Neemat-Allah M, Degheili J, Sarhan M. Seropositivity of toxoplasmosis among hemodialysis children patients at Zagazig University Pediatrics Hospital, Egypt. Parasitol United J. 2022;15:53-9.
22. Kadkhodaei S, Jahromi ZK, Taghipour A, Rezanezhad H, Solhjoo K. A Case-Control Seroprevalence Survey of Toxoplasmosis in Hemodialysis Patients and Healthy Subjects in Kazeroon and Jahrom Districts in Fars Province, Southern Iran. J Parasitol Res 2023;2023:3-12.
23. Bayani M, Mostafazadeh A, Oliaee F, Kalantari N. The Prevalence of *Toxoplasma gondii* in Hemodialysis Patients. Iran Red Crescent Med J. 2013;15:e5225.
24. Babekir A, Mostafa S, Obeng-Gyasi E. The Association of *Toxoplasma gondii* IgG Antibody and Chronic Kidney Disease Biomarkers. Microorganisms. 2022;10.
25. Soltani S, Kahvaz MS, Soltani S, Maghsoudi F, Foroutan M. Seroprevalence and associated risk factors of *Toxoplasma gondii* infection in patients undergoing hemodialysis and healthy group. BMC Res Notes. 2020;13:551-66.
26. Saki J, Khademvatan S, Soltani S, Shahbazian H. Detection of toxoplasmosis in patients with end-stage renal disease by enzyme-linked immunosorbent assay and polymerase chain reaction methods. Parasitol Res. 2013;112:163-98.
27. Hussein S, Molan A-L. Prevalence of *Toxoplasma gondii* Infection in Hemodialysis Patients with Chronic Renal Failure and Risk Factors in Diyala Province, Iraq. Malays J Med Health Sci. 2019;15:4-12.
28. Elgodwi S, Mohamed AS. The prevalence of *Toxoplasma gondii* infection in hemodialysis patients in the capital city of libya tripoli region. J Appl Sci. 2021:47-54.
29. Lima MLF, Sousa AMAFLSd, Marques LL, Ferreira IB, Giuffrida R, Kmetiuk LB, et al. Household location (urban, peri-urban and rural settlements) as an associated risk factor for toxoplasmosis during pregnancy in Southeastern Brazil. Tropb Med Infect Dis. 2024;9:173-87.
30. Hamidi F, Rostami A, Hosseini SA, Calero-Bernal R, Hajavi J, Ahmadi R, et al. Anti-*Toxoplasma gondii* IgG seroprevalence in the general population in Iran: A systematic review and meta-analysis, 2000-2023. PLoS One. 2024;19:4-12.
31. Moawad H, Etewa S, Mohammad S, Neemat-Allah M, Degheili J, Sarhan M. Seropositivity of

toxoplasmosis among hemodialysis children patients at Zagazig University Pediatrics Hospital, Egypt. Parasitologists United Journal. 2022;15:53-9.
32. Foroutan M, Majidiani H, Dalvand S, Daryani A, Kooti W, Saki J, et al. Toxoplasmosis in Blood Donors: A Systematic Review and Meta-Analysis. Transfus Med Rev. 2016;30:116-22.
33. Salem MS, Shaker MJ, Mohammed NK. Impact of toxoplasmosis in im-mune respons in hemodialysis patients. Diyala Journal of Medicine. 2022;22:1-11.
34. Montoya JG. Laboratory diagnosis of *Toxoplasma gondii* infection and toxoplasmosis. J Infect Dis. 2002;185 Suppl 1:S73-82.
35. Abood MA, Saheb EJ. The effect of toxoplasmosis on renal function in hemodialysis patients. Ann Parasitol. 2022;68:685-92.
36. Al-Khafaji, A. H., Al-Taie, H H. *Toxoplasma gondii* IgG seropositivity and renal function markers in hemodialysis patients in Baghdad. J Egypt Soc Parasitol. 2022:8-12.
37. Rahimi M, Javanmardi F, Shokri A. Association between *Toxoplasma gondii* IgG seropositivity and estimated glomerular filtration rate in chronic kidney disease patients: Evidence from the Mazandaran CKD Registry. Evidence from the Mazandaran CKD Registry. 2023:4-23.
38. Alvarado-Esquivel C, Sánchez-Anguiano LF, Hernández-Tinoco J, Arreola-Cháidez E, López J, Salcido-Meraz KI, et al. High Seroprevalence of *Toxoplasma Gondii* Infection in Female Sex Workers: A Case-Control Study. Eur J Microbiol Immunol (Bp). 2015;5:285-92.

To cite this article: Atef H. Hussein, Nagwa S. Aly, Gehan A. Rashed, Enas M. Mohamed Ali, Fatma S. Ibrahim, Doaa I. Mohamed. Seroprevalence of Toxoplasma Gondii among Hemodialysis Patients in Qalyubia Governorate, Egypt. BMFJ XXX, DOI: 10.21608/bmfj.2025.423352.2664.