Seropositivity of toxoplasmosis among hemodialysis children patients at Zagazig University Pediatrics Hospital, Egypt

Original Article

Howayda SF Moawad[1], Samia E Etewa[1], Samira M Mohammad[1], Mayy A Neemat-Allah[2], Jad A Degheili[3], Mohamed H Sarhan[1]

Departments of Medical Parasitology[1], and Pediatrics[2], Faculty of Medicine, Zagazig University, Zagazig 44519, Egypt, Division of Pediatric Urology, Department of Surgery, Children's Hospital of Eastern Ontario, University of Ottawa, Ontario K1H 8L1, Canada[3]

ABSTRACT

Background: Toxoplasmosis is a universal opportunistic infection that causes severe complications in immunosuppressed patients. Renal failure is a state of immunodeficiency, especially in children. Therefore, hemodialysis patients may be at high risk for toxoplasmosis.
Objective: To investigate the seropositivity rate of *T. gondii* specific antibodies (anti-*T. gondii* IgM and IgG antibodies) in pediatric hemodialysis patients.
Subjects and Methods: ELISA was used to test serum samples from 67 children on regular hemodialysis and 50 healthy controls for anti-*Toxoplasma* IgG and IgM antibodies in this case-control research. Demographic criteria, duration of hemodialysis, and possible risk factors for toxoplasmosis were recorded. All participants were clinically examined to detect any signs suggestive of toxoplasmosis.
Results: In comparison to total *T. gondii* seropositivity in all participants (23%), it was 16% and 28% in control and hemodialysis groups, respectively. The IgG antibodies were detected in 19 hemodialysis cases and eight control cases. The mean duration of hemodialysis among *T. gondii* seropositive and seronegative patients were 47.6±14.3 and 22.3±6.7 months, respectively. Among *T. gondii* seropositive individuals, the average duration of hemodialysis was substantially longer. In the examined groups, contact with cats and eating semi-cooked meat were the risk factors recorded for *T. gondii* seropositivity.
Conclusion: Toxoplasmosis seropositivity rate was higher in hemodialysis children than in the control group. For early identification and treatment, *T. gondii* screening should be done for all hemodialysis patients before and during hemodialysis.

Keywords: anti-*Toxoplasma* antibodies; ELISA; hemodialysis; renal failure; toxoplasmosis.

Received: 13 November, 2021; **Accepted:** 1 February, 2022.

Corresponding Author: Mohamed H. Sarhan, **Tel.:** +20 1020260608, **E-mail:** drsarhan@gmail.com

Print ISSN: 1687-7942, **Online ISSN:** 2090-2646, **Vol. 15, No. 1, April, 2022.**

INTRODUCTION

Toxoplasmosis is a zoonotic illness caused by *T. gondii*, an obligate intracellular protozoan[1]. It is a largely undiagnosed, highly neglected disease that can be fatal in humans and animals worldwide[2]. *T. gondii* infects more than a third of the world's population[3]. Infection may be contracted by eating *T. gondii* tissue cysts in undercooked or raw meat from infected animals or birds. Swallowing infective oocysts shed by infected cats to contaminate soil, water, and plants, poses a substantial infection source[2]. Other transmission routes as transplacental, organ transplantation, and blood transfusion can occur[4]. The disease can be due to an acquired recent infection or reactivation of latent infection[5].

In immunocompetent individuals, toxoplasmosis is mainly asymptomatic or presents as mild fever and swelling of lymph nodes. In immunocompromised individuals such as hemodialysis patients, organ transplant recipients, AIDS, or malignancy patients, latent forms of the protozoan can be activated and cause generalized lymphadenopathy, encephalitis, cerebral calcifications, epilepsy, myocarditis, pneumonia, and even death[6,7].

Renal failure is a global public health issue increasing in prevalence with occasional unfavorable outcomes; and requires expensive management[8]. The most common causes of renal failure in children are chronic glomerulonephritis, congenital anomalies of the urinary system as polycystic kidney disease, renal hypoplasia, dysplasia, obstructive uropathy, steroid-resistant nephrotic syndrome, hemolytic uremic syndrome, autoimmune disorders as systemic lupus erythematosus, diabetic and hypertensive nephropathy[9,10]. Advanced stages of renal failure need renal replacement therapy as dialysis or renal transplantation that requires long-term immunosuppressive therapy[11].

One of the most severe and life-threatening problems in dialysis patients is immune system dysfunction. After cardiovascular illnesses, it is the second most common cause of high morbidity and mortality rates among chronic renal failure patients[12]. This impairment results from disturbed normal renal functions and subsequent uremic toxins accumulation in patients' blood[10]. These toxins impair humoral and cellular immunity due to high B and T cell apoptosis with consequent lymphopenia, malfunction of the cluster of differentiation 4 ($CD4^+$)

 DOI: 10.21608/PUJ.2022.105855.1144

T- cells, and decreased phagocytic ability of neutrophils and monocytes[13].

This immunosuppressive state renders these patients more susceptible to various opportunistic infections, including toxoplasmosis, and are at higher risk of latent infection reactivation[14]. Hence, a rapid and definitive diagnosis of toxoplasmosis is important in hemodialysis patients[15]. Specific IgM antibodies are used to diagnose patients for acute toxoplasmosis because these antibodies can be detected at high serum titers during the onset of the disease. Meanwhile, specific IgG antibodies are indicative of chronic toxoplasmosis (previous or latent infection)[16].

The main goal of this study is to determine the seropositivity rate of *T. gondii* specific antibodies (anti-*T. gondii* IgG and IgM antibodies) using ELISA in hemodialysis patients attending the Hemodialysis Unit at Zagazig University Pediatrics Hospital in Sharqia Governorate, Egypt, compared to healthy controls.

SUBJECTS AND METHODS

This case-control study was conducted at the Hemodialysis Unit of Zagazig University Pediatrics Hospital and Medical Parasitology Department, Faculty of Medicine, Zagazig University, from May 2019 to March 2020.

Study design and population: One hundred seventeen cases aged ≤18 years participated in this study, and they were categorized according to their renal status into two groups; the hemodialysis group (n=67) and the control group (n=50). The hemodialysis group included children with chronic renal failure who were on regular hemodialysis (by an arteriovenous fistula or graft) three times per week. These patients did not suffer from other diseases causing immunosuppression such as malignancy, AIDS, diabetes mellitus, bronchial asthma, or received immunosuppressive therapy. At the same time, the control group included healthy participants with no history of renal troubles or any chronic debilitating disease, and their kidney function tests were within the normal range. A comprehensive questionnaire was recorded from all participants, including demographic data (age, gender, residence), duration of hemodialysis, and possible risk factors for toxoplasmosis as the history of contact with cats, eating undercooked meat, or blood transfusion. All participants were clinically examined to detect any signs suggestive of *T. gondii* infection such as fever, skin rash, enlarged lymph nodes, CNS impairment, or organomegaly.

Sampling and serological immunoassays: Sera were obtained from each participant under strict aseptic conditions. Labeled sera were kept at -20C°. Using commercial ELISA kits, serum samples were tested at a wavelength of 450 nm for anti-*Toxoplasma* IgM and IgG antibodies according to the manufacturer's recommendations (GENESIS diagnostics, California, USA, Product Code: GD081and GD080, respectively) on an ELISA microplate reader (SLT Lab Instruments, A-5082 Grödig /Salzburg, Austria, serial number. 216692). Results were defined semi-quantitatively by dividing the OD of the test samples by the OD of the calibrator control samples. Antibody index ≥1.1 (≥32 IU/ml) was considered as a seropositive result of *T. gondii* infection; antibody index 0.9-1.1 was considered borderline positive and re-tested; and antibody index <0.9 (<32 IU/ml) was considered as seronegative. The *T. gondii*-specific IgM, IgG, or both reacting samples were confirmed positive.

Statistical analysis: The statistical package for the social sciences (SPSS) software was used to gather, tabulate, and analyze the data. The chi-square test and the t-test were used. Statistical significance was defined as a *P* value of less than 0.05.

Ethical consideration: The study was authorized by Zagazig Faculty of Medicine's Ethical Committee, Egypt. After explaining the purpose of the study, informed consent was obtained from each participant's parents. Results were informed to all participants.

RESULTS

In the present study, the mean age of the hemodialysis cases was 13.6±3.2 years and 10.2±2.7 years for the control cases, with significant statistical differences between both groups. Still, there were insignificant statistical differences between them concerning gender and residence. Male patients represented the highest percentage of both groups, and also, most of them were rural inhabitants. Both groups showed significant statistical differences concerning the possible risk factors for toxoplasmosis except for drinking raw milk (Table 1).

The overall *T. gondii* seropositivity among the hemodialysis and control groups was 23%. Hemodialysis patients had higher total seropositivity (28%) than control participants (16%). Anti-*Toxoplasma* IgM antibodies were not detected in both groups. However, IgG antibodies were detected in 19 hemodialysis cases and eight control cases with insignificant statistical differences between both groups (Table 2).

According to the cause of renal failure in the hemodialysis group, 22 (33%) patients had a history of chronic glomerulonephritis, 14 (21%) patients had a history of congenital urological malformations, 8 (12%) patients had a history of steroid-resistant nephrotic syndrome, 4 (6%) patients had a history of lupus nephritis, 3 (4%) patients had a history

Table 1. Demographic data and the possible risk factors for toxoplasmosis among hemodialysis and control groups.

	Hemodialysis group (n=67)	Control group (n=50)	Total (n=117)	Statistical analysis	
	Mean ± SD			*t*-test	*P* value
Age (Years)	13.6 ± 3.2	10.2 ± 2.7	---	**3.76**	**0.04***
	No. (%)			X^2-test	*P* value
Gender					
Male	41 (61%)	29 (58%)	70 (60%)	**0.12**	**NS**
Female	26 (39%)	21 (42%)	47 (40%)		
Residence					
Rural	43 (64%)	26 (52%)	69 (59%)	**1.67**	**NS**
Urbam	24 (36%)	24 (48%)	48 (41%)		
Contact with cats					
Yes	37 (55%)	11 (22%)	48 (41%)	**13.06**	**0.000***
No	30 (45%)	39 (78%)	69 (59%)		
Contact with soil					
Yes	6 (9%)	11 (22%)	17 (15%)	**3.92**	**0.048***
No	61 (91%)	39 (78%)	100 (85%)		
Semi-cooked meat					
Yes	21 (31%)	32 (64%)	53 (45%)	**12.32**	**0.000***
No	46 (69%)	18 (36%)	64 (55%)		
Raw milk					
Yes	13 (19%)	6 (12%)	19 (15%)	**1.15**	**NS**
No	54 (81%)	44 (88%)	98 (85%)		
Blood transfusion					
Yes	36 (54%)	2 (4%)	38 (32%)	**32.30**	**0.000***
No	31 (46%)	48 (96%)	79 (68%)		

n: Number of cases; **SD:** Standard deviation; ***:** Significant difference ($P<0.05$); **NS:** Non-significant difference ($P\geq0.05$).

Table 2. Serological tests for anti-*T. gondii* antibodies among the hemodialysis and control groups.

	Hemodialysis group (n=67)	Control group (n=50)	Total (n=117)	Statistical analysis	
	No. (%)			X^2-test	*P* value
IgG positive	19 (28%)	8 (16%)	27 (23%)	2.5	NS
IgM positive	0 (0%)	0 (0%)	0 (0%)	0.0	NS
Total seropositivity	19 (28%)	8 (16%)	27 (23%)	2.5	NS

n: Number of cases; **NS:** Non-significant difference ($P\geq0.05$).

of the hemolytic uremic syndrome, and 16 (24%) patients had an unknown cause of renal failure. There were insignificant statistical differences between all groups concerning the total number of IgG and IgM *Toxoplasma* seropositivity. *T. gondii* antibodies were detected in 9 (47%) patients with a history of chronic glomerulonephritis, 3 (16%) patients with a history of congenital urological malformation, 1 (5%) patient with a history of the hemolytic uremic syndrome, 2 (11%) patients with a history of steroid-resistant nephrotic syndrome, and 4 (21%) patients with unknown cause of renal failure (Table 3).

The mean age of the *T. gondii* seropositive patients was 12.4±2.7 years, and 11.8±1.6 years for the *T. gondii* seronegative patients with insignificant statistical difference between both groups, but there was a significant statistical difference between them concerning the duration of hemodialysis (47.6+2.7 versus 22.3+6.7). Female patients showed an insignificant higher percentage of *T. gondii* seropositivity than male patients (56% versus 44%) who had the higher percentage in the seronegative group; insignificantly most seropositive patients (43:64%) were rural inhabitants. Concerning the possible risk factors for *T. gondii* infection, the statistical differences between both groups were insignificant except for contact with cats (59%) and consuming semi-cooked meat (70%) (Table 4).

Among cases positive for *T. gondii* infection; fever, headache, fatigue, and organomegaly were found in 10

Table 3. The underlying causes of renal failure among the hemodialysis group and associated *T. gondii* total seropositivity.

Renal failure		*T. gondii* seropositivity	Statistical analysis	
Cause	**No. (%)**	**No. (%)**	X^2-test	*P* value
Chronic glomerulonephritis	22 (33%)	9 (47%)	**2.03**	**NS**
Congenital urological malformations	14 (21%)	3 (16%)		
Hemolytic uremic syndrome	3 (4%)	1 (5%)		
Steroid-resistant nephrotic syndrome	8 (12%)	2 (11%)		
Lupus nephritis	4 (6%)	0 (0%)		
Unknown cause	16 (24%)	4 (21%)		
Total	67 (100%)	19 (100%)		

NS: Non-significant difference ($P\geq0.05$).

(37%), 12 (44%), 17 (63%), and 8 (30%) respectively, with a statistically significant difference when compared to the *T. gondii* negative cases. While skin rash, blurring of vision, and lymphadenopathy were found in 6 (22%), 7 (26%), and 6 (22%), respectively, with a statistically insignificant difference when compared to the *T. gondii* negative cases (Table 5).

Table 4. Demographic data, duration of hemodialysis and the possible risk factors for toxoplasmosis among hemodialysis and control groups.

	T. gondii **seropositive patients (n=27)**	*T. gondii* **seronegative patients (n=90)**	**Total (n=117)**	**Statistical analysis**	
	No. (%)			X^2**-test**	***P* value**
Gender					
Male	12 (44%)	58 (64%)	70 (60%)	**3.64**	**NS**
Female	15 (56%)	32 (36%)	47 (40%)		
Residence					
Rural	18 (67%)	51 (57%)	69 (59%)	**0.86**	**NS**
Urbam	9 (33%)	39 (43%)	48 (41%)		
Contact with cats					
Yes	16 (59%)	32 (36%)	48 (41%)	**4.82**	**0.028***
No	11 (41%)	58 (64%)	69 (59%)		
Contact with soil					
Yes	5 (19%)	12 (13%)	17 (15%)	**0.44**	**NS**
No	22 (81%)	78 (87%)	100 (85%)		
Semi-cooked meat					
Yes	19 (70%)	34 (38%)	53 (45%)	**8.9**	**0.003***
No	8 (30%)	56 (62%)	64 (55%)		
Raw milk					
Yes	3 (11%)	16 (18%)	19 (15%)	**0.68**	**NS**
No	24 (89%)	74 (82%)	98 (85%)		
Blood transfusion					
Yes	5 (19%)	33 (37%)	38 (32%)	**32.30**	**0.000***
No	22 (81%)	57 (63%)	79 (68%)		
	Mean ± SD			X^2**-test**	***P* value**
Age (Years)	12.4 ± 2.7	11.8 ± 1.6		**2.83**	**NS**
Duration of hemodialysis (M)	47.6 ± 14.3	22.3 ± 6.7		**6.96**	**0.000***

n: Number of cases; SD: Standard deviation; M: month; ***:** Significant difference ($P<0.05$); **NS:** Non-significant difference ($P\geq0.05$).

Table 5. The association of clinical manifestations with *T. gondii* seropositivity among the studied hemodialysis patients and the control group.

	Seropositive (n=27)	**Seronegative (n=90)**	**Total (n=117)**	**Statistical analysis**	
	No. (%)			X^2**-test**	***P* value**
Fever					
Yes	10 (37%)	16 (18%)	26 (22%)	**4.46**	**0.035***
No	17 (63%)	74 (82%)	91 (78%)		
Headache					
Yes	12 (44%)	21 (23%)	33 (28%)	**4.57**	**0.033***
No	15 (56%)	69 (77%)	84 (72%)		
Skin rash					
Yes	6 (22%)	29 (32%)	35 (30%)	**0.92**	**NS**
No	21 (78%)	61 (68%)	82 (60%)		
Blurring of visionl					
Yes	7 (26%)	11 (12%)	18 (15%)	**3.00**	**NS**
No	20 (74%)	79 (88%)	99 (85%)		
Fatigue					
Yes	17 (63%)	19 (21%)	36 (31%)	**17.1**	**0.000***
No	10 (37%)	71 (79%)	81 (69%)		
Lymphadenopathy					
Yes	6 (22%)	8 (9%)	14 (12%)	**3.50**	**NS**
No	21 (78%)	72 (91%)	103 (88%)		
Organomegaly					
Yes	8 (30%)	12 (13%)	20 (17%)	**3.90**	**0.049***
No	19 (70%)	78 (87%)	97 (83%)		
Asymptomatic	4 (15%)	32 (36%)	36 (31%)	**4.19**	**0.041***

n: Number of cases; ***:** Significant difference ($P<0.05$); **NS:** Non-significant difference ($P\geq0.05$).

DISCUSSION

In fact, parasitic infections play a significant role in developing illnesses, particularly in immunocompromised patients and young children[17]. Because of the impaired immune system of hemodialysis patients, reactivation of *T. gondii* tissue cysts produces a high and dangerous recurrence of the chronic form of toxoplasmosis[18]. The goal of the current study was to evaluate the prevalence of toxoplasmosis in pediatric hemodialysis patients compared to healthy cases. The three most common reported etiologies (chronic glomerulonephritis, congenital urological malformations and unknown etiology) of end-stage renal disease in our case-control study, were, congruent with those reported by Youssef and Neemat-Allah[19].

Toxoplasmosis diagnosis can be achieved via serological tests, mouse inoculation, demonstration of the parasite in tissues, Polymerase Chain Reaction (PCR), and tissue culture of clinical specimens. Other less common methods include skin tests and detection of *Toxoplasma* antigen in serum and body fluids. However, quantification of specific antibodies by microscopic detection of neutralized *T. gondii* tachyzoites (Sabin-Feildman dye test) and serological evaluation of *Toxoplasma*-specific IgM and IgG antibodies are considered gold standards[20]. During acute primary infection with *T. gondii*, anti-*T. gondii* IgM is initially produced. However, IgM titers decline over the next few months, becoming undetectable within a year. The immune system also produces anti-*T. gondii* IgG a few weeks after the initial infection. IgG antibody levels usually peak within one or two months after the infection and persist throughout the lifetime of the infected person[21].

In our study, the *T. gondii* seropositivity in the hemodialysis patients (28%) as determined by both IgG and IgM evaluation was insignificantly higher than the overall estimate (23%) and the control participants (16%). This rate is higher than that reported by Sharaf *et al*.[10] who detected 22% *T. gondii* seropositivity in pediatric hemodialysis patients in Cairo Governorate. However, our records were lower than those of Hamza *et al*.[9], who discovered *T. gondii* seropositivity among adult hemodialysis patients (61.7%) and renal transplant recipients (70.0%) in Alexandria Governorate. Similarly, it is lower than rates in other nations such as Iran (74-76.8%)[1,7], Turkey (56.0%-76.5%)[22], and Mexico (56.7%)[23].

The anti-*Toxoplasma* IgM antibodies were not detected in hemodialysis patients, indicating that those patients were not recently exposed to infection sources or had a reactivation of latent infection. These results agree with Fallahizadeh *et al*.[6] and Hussein and Molan[4], who did not detect anti-*Toxoplasma* IgM antibodies in hemodialysis patients. In contrast, Aufy *et al*.[24] detected (16.7%) prevalence among hemodialysis patients and (24.1%) among renal transplant recipients; Shehata *et al*.[25] reported (3.3%), and Sharaf *et al*.[10] reported (2%) prevalence among hemodialysis adult and children patients, respectively.

In the present study, *T. gondii* IgG seropositivity was insignificantly higher in the hemodialysis group (28%) than in the control group (16%). Similarly, Sharaf *et al*.[10] detected (20%) among hemodialysis patients and (15%) among the control group. But these results were lower than those of other studies reported by Ocak *et al*.[22] (76.5%) among hemodialysis patients and (48%) in control subjects; Aufy *et al*.[24], who detected 56.7% in hemodialysis patients and 23.1% in the control group; Solhjoo *et al*.[26] who detected 59.10% among hemodialysis patients and 36.40% among healthy individuals; and Bayani *et al*.[27] whose record reached 80% in hemodialysis patients and 76% in the healthy group. Keeping in mind that IgG seropositivity indicates toxoplasmosis chronicity, the infection may have been acquired before hemodialysis treatment. With the extension of hemodialysis, the disease reached chronicity. Notably, reactivation of latent toxoplasmosis is risky in those immunocompromised patients during dialysis treatment.

There was an insignificant statistical difference between *T. gondii* seropositive and seronegative groups regarding the age in our study. A similar result was obtained in a recent study conducted among the hemodialysis pediatric patients at Ain Shams University Pediatric Hemodialysis Unit[10]. Besides, exposure to toxoplasmosis was reported to increase with age[28,29]. Similarly, no statistically significant differences in the percentage of *T. gondii* seropositivity were observed between male and female patients and also between rural and urban inhabitants. This agrees with other studies[4,27,30] that did not find a significant relationship between *T. gondii* infection rate and gender and residence. In contrast, other studies fond a correlation[31]. The observed diversity could be explained by the differences in sampling methods and lifestyles.

The mean duration of hemodialysis was significantly higher in our series of *T. gondii* seropositive patients. This agrees with other reports[22,32,33] that also detected a higher mean duration of hemodialysis among seropositive patients than seronegative ones. As such, the more prolonged exposure to hemodialysis, the higher the risk for developing toxoplasmosis.

Among the studied risk factors for toxoplasmosis, our significant recorded 59% revealed that contact with cats is indeed a risk factor for toxoplasmosis. Consumption of semi-cooked meat is another risk factor. These results agreed with those reported by two other studies[18,34]. On the contrary, concerning animal

exposure, a recent study[10] detected an insignificant difference between *T. gondii* seropositive and seronegative patients.

There was no significant correlation found between *T. gondii* seropositivity and other risk factors such as raw milk consumption or blood transfusion. This may be attributed to the modesty of the sample size, which presented a limitation for the analysis, thus explaining the statistical insignificance.

Among cases positive for *T. gondii* infection, nonspecific clinical manifestations as fatigue, headache, and fever were reported with a statistically significant difference compared to *T. gondii* seronegative cases. Additionally our study reported organomegaly and lymphadenopathy less frequently, and neurological manifestations of toxoplasmosis were not recorded. Similar results were reported[9,35]. However, there was no statistically significant increase in the prevalence of organomegaly in their studied patients[27]. This may be explained in immunocompromised patients by the occurence of non-specific clinical manifestations of infections in general that may be indistinguishable from the manifestations of the underlying disease *per se*.

In conclusion, hemodialysis patients appeared to have greater *Toxoplasma* seropositivity than healthy controls, implying their higher risk for toxoplasmosis. Toxoplasmosis screening, either serological or molecular, is required before and throughout dialysis treatment. This may aid in the prevention and control of infection in particular patient groupings.

Author contribution: Moawad HSF contributed to the study design, practical work, data analysis, and writing the article draft. Etewa SE contributed to the study design and critical revision for the final approval. Sarhan MH contributed to the study design, data analysis, writing the article draft, and critical revision for the final approval. Mohammad SM contributed to the practical work, data analysis, and writing the aricle draft. Neemat-Allah MA contributed to the practical work, data analysis, and writing the aricle draft. Degheili JA contributed to data analysis, and critical revision for the final approval.

Conflicts of interest: No conflict of interest.

Financial support: None.

REFERENCES

1. Saadat F, Mahmoudi MR, Rajabi E, Roshan ZA, Shad BM, Karanis P. Seroepidemiology and associated risk factors of *Toxoplasma gondii* in hemodialysis patients. Acta Parasitol 2020; 65(4):906–912.
2. Abbas IE, Villena I, Dubey JP. A review on toxoplasmosis in humans and animals from Egypt. Parasitology 2020; 147 (2):135–159.
3. Wana MN, Moklas MAM, Watanabe M, Nordin N, Unyah NZ, Abdullahi SA, *et al*. A Review on the prevalence of *Toxoplasma gondii* in humans and animals reported in Malaysia from 2008-2018. Int J Environ Res Public Health 2020; 17(13):4809.
4. Hussein S, Molan A. Prevalence of *Toxoplasma gondii* infection in hemodialysis patients with chronic renal failure and risk factors in Diyala province, Iraq. Mal J Med Health Sci 2019; 15(1):31-36.
5. Hamidi F, Etemadi J, Mehrabani NG, Oskouei MM, Motavalli R, Ardalan MR. Comparison of *Toxoplasma gondii* seropositivity in hemodialysis and peritoneal dialysis patients. J Coast Life Med 2015; 3(8):621-622.
6. Fallahizadeh S, Feizhadad M, Kazemi F. Toxoplasmosis in hemodialysis and healthy individuals in Shush County, Southwest of Iran. Int J BioMed Public Health 2018; 1(3):122-126.
7. Mahmoudi MR, Rahmati B. Coinfection of *Toxoplasma gondii* and intestinal parasites among elderly immunocompromised patients. Elder Health J 2020; 6(1):31-35.
8. Tamadon MR. Immunity and chronic kidney disease. Immunopathol Persa 2016; 2(2): e16.
9. 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(1):7–15.
10. Sharaf M, El-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. Afro-Egypt J Infect Endem Dis 2021; 11(2):134-145.
11. Burkhalter F, Steiger J, Dickenmann M. A road map for patients with imminent end-stage renal disease. Swiss Med Wkly 2012; 142: w13713.
12. Tonelli M, Wiebe N, Culleton B, House A, Rabbat C, Fok M, *et al*. Chronic kidney disease and mortality risk: a systematic review. J Am Soc Nephrol 2006; 17(7):2034–2047.
13. Elbadawy A, Ezzat A, Elkholy A. Detection rate of common intestinal parasites in end stage renal disease patients under maintenance hemodialysis in Benha University Hospital, Egypt. PUJ 2021; 14(1):29-33.
14. Moawad H, AboZaid A, Ibrahim H, Etewa S, Mohammad S. Prevalence of intestinal parasitic infections among Egyptian children with chronic kidney diseases in Zagazig University Children's Hospital. Zagazig Univ Med J 2020; DOI:10.21608/ZUMJ.2020.48886.2003
15. 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(1):163–168.
16. Mao F, Yang Y, Chen Y, Zhang Q, Ding X, Ni B, *et al*. Seroprevalence and risk factors of *Toxoplasma gondii* infection among high-risk populations in Jiangsu Province, Eastern China. Front Cell Infect Microbiol 2021; 11:783654.
17. Drawany ZE, Saleh SH, Etewa SE, Ibrahim SM. Prevalence of intestinal parasites among type 1 diabetic patients

in pediatrics Zagazig University Hospital. Endocrinol Metab Int J 2019; 7(6):171-179.
18. Arefkhaha N, Hosseini SA, Karimzade R, Moshfe A, Hadinia F, Larki RA, *et al*. Seroprevalence and risk factors of *Toxoplasma gondii* infection among cancer and hemodialysis patients in southwest Iran. Clin Epidemiol Glob Health 2019; 7:596–599.
19. Youssef DM, Neemat-Allah MA. Hemodialysis in children: eleven years in a single center in Egypt. Iran J Kidney Dis 2013; 7(6):468–474.
20. Liu Q, Wang ZD, Huang SY, Zhu XQ. Diagnosis of toxoplasmosis and typing of *Toxoplasma gondii*. Parasit Vectors 2015; 8:292.
21. Agordzo SK, Badu K, Addo MG, Owusu CK, Mutala AH, Tweneboah A, *et al*. Seroprevalence, risk factors and impact of *Toxoplasma gondii* infection on haematological parameters in the Ashanti region of Ghana: a cross-sectional study. AAS Open Res. 2020; 2:166.
22. Ocak S, Duran N, Eskiocak AF, Aytac H. Anti-*Toxoplasma gondii* antibodies in hemodialysis patients receiving long-term hemodialysis therapy in Turkey. Saudi Med J 2005; 26(9):1378–1382.
23. Alvarado-Esquivel C, Liesenfeld O, Torres-Castorena A, Estrada-Martínez S, Urbina-Alvarez JD, Ramos-de la Rocha M, *et al*. Seroepidemiology of *Toxoplasma gondii* infection in patients with vision and hearing impairments, cancer, HIV, or undergoing hemodialysis in Durango, Mexico. J Parasitol 2010; 96(3):505–508.
24. Aufy SM, Mahgoub AM, Saadi MG, Elmallawany MA. Serological detection of *Toxoplasma gondii* in chronic renal failure patients and renal transplant recipients. J Egypt Soc Parasitol 2009; 39(3):943–950.
25. Shehata AI, Hassanein F, Abdul-Ghani R. Opportunistic parasitoses among Egyptian hemodialysis patients in relation to $CD4^+$ T-cell counts: A comparative study. BMC Infect Dis 2019; 19:480.
26. Solhjoo K, Jahromi AS, Parnian-Rad A. Anti-*Toxoplasma gondii* antibodies in haemodialysis patients. Am J Infect Dis 2010; 6(1):13-17.
27. Bayani M, Mostafazadeh A, Oliaee F, Kalantari N. The prevalence of *Toxoplasma gondii* in hemodialysis patients. Iran Red Crescent Med J 2013; 15(10):e5225.
28. Al-Zaaiydi JM. Seroepidemiological study of toxoplasmosis in woman in some areas of El- Jabal El-Akhdar distract. [In Arabic], Thesis, Zoology Department, Faculty of Sciences, Omar Al-Mukhtar University, Albeda, Libya, 2007.
29. Elgodwi S. Study of risk factors for *Toxoplasma gondii* infection in Tripoli. Alq J Med App Sci 2017; 1(1):52-59.
30. Jones JL, Muccioli C, Belfort R, Jr Holland GN, Roberts JM, Silveira C. Recently acquired *Toxoplasma gondii* infection. Brazil Emerg Infect Dis 2006; 12(4):582–587.
31. Mostafavi SN, Ataei B, Nokhodian Z, Yaran M, Babak A. Seroepidemiology of *Toxoplasma gondii* infection in Isfahan province, central Iran: A population based study. J Res Med Sci 2011; 16(4):496–501.
32. Yazar S, Demirtaş F, Yalçin S, Yaman O, Tokgöz B, Utaş C, *et al*. Anti-*Toxoplasma gondii* antibodies in haemodialysis patients with chronic renal failure. Yonsei Med J 2003; 44(2):288–292.
33. Nahnoush RK, Youssif EM, Hassanin OM. Detection of toxoplasmosis in hemodialysis Egyptian patients using serological and molecular techniques. Aust J Basic Appl Sci 2016; 10(6):197-201.
34. Rostami A, Seyyedtabaei SJ, Aghamolaie S, Behniafar H, Lasjerdi Z, Abdolrasouli A, *et al*. Seroprevalence and risk factors associated with *Toxoplasma gondii* infection among rural communities in Northern Iran. Rev Inst Med Trop Sao Paulo 2016; 58:70.
35. Mahgoub AM, Aufy SM, Saadi MG, Elmallawany MA. Risk factors predisposing to toxoplasmosis in chronic renal failure patients and renal transplant recipients. J Egypt Soc Parasitol 2009; 39(3):963–973.