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Toxoplasmosis in HIV and non HIV prisoners in Malaysia

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Abstract. This is the first Malaysian study to determine the trend and risk factors of *Toxoplasma gondii* infection in HIV and non-HIV among prisoners in terms of socio-demographic and behavioural characteristics, clinical presentations and haematological distributions. Blood samples from 303 participants, comprising 133 HIV positive and 170 HIV negative inmates were collected in EDTA and plain tubes. Two mls of each blood sample in plain tubes were centrifuged at 1500 rpm for 10 minutes and the sera obtained were subjected to ELISA for detection of *Toxoplasma* IgM and IgG antibody towards *Toxoplasma* antigen. Seropositive samples for *Toxoplasma* IgM or both *Toxoplasma* IgM and IgG were further tested with Novalisa *Toxoplasma gondii* IgG avidity test to rule out acute from latent infections. Blood in EDTA tubes were sent to Clinical Diagnostic Lab (CDL), University Malaya Medical Centre (UMMC), Kuala Lumpur for complete blood count and differential count analysis. Overall seroprevalence of anti-*T. gondii* antibodies was detected in 41.9% (127 out of 303) of the participants. Anti-*T. gondii* antibodies was detected in 63.2% (84 out of 133) of HIV positive subjects and in 25.3% (43 out of 170) of HIV negative subjects. Seroprevalence of anti-*T. gondii* antibodies was significantly higher in HIV positive than in HIV negative subjects (OR = 5.06; 95% CI = 3.09-8.30; $p < 0.001$). The rate of *T. gondii* seropositivity increased significantly in those aged 40 years and above, HIV positive individuals and those with history of drug abuse. White blood cells (WBCs), neutrophils and basophils counts decreased significantly in those infected with *Toxoplasma*. Creating awareness about *T. gondii* infection and follow-up of their status is recommended. Moreover, screening of *T. gondii* infection in HIV-infected individuals should be considered for better treatment and management, including control and prevention.

INTRODUCTION

Toxoplasmosis is a zoonotic disease caused by an ubiquitous, intracellular, protozoan parasite known as *Toxoplasma gondii*. It is estimated one third of the world population were infected with *T. gondii* but most are asymptomatic (Hill *et al.*, 2005). *Toxoplasma* infection is usually acquired through ingestion of contaminated raw meats containing tissue cysts of *Toxoplasma*, ingestion of vegetables or water contaminated with oocyst from cat faeces or via transplacental. *Toxoplasma* infection can also be acquired by accidental inoculation of zoite in the laboratory, blood or leukocyte transfusion, or from a transplanted organ, however these incidents are rare (Nissapatorn & Abdullah, 2004; Ngui *et al.*, 2011). Toxoplasmosis in healthy individuals is clinically unapparent (presenting with flu-like symptoms) or self-limited. Whilst, infected immunocompromised (i.e. HIV-infected) individuals may experience severe symptoms due to reactivation of latent toxoplasmosis which leads to development of toxoplasmic encephalitis (TE). They may present with fever, confusion, headache, seizures, nausea, and poor coordination (CDC, 2014). TE is one of the most frequent opportunistic infections (OIs), particularly in patients with full-blown acquired immunodeficiency syndrome (AIDS). TE complicates AIDS (Nissapatorn *et al.*, 2004).

Numerous studies across Malaysia reported high prevalence of toxoplasmosis in the general population. It was reported 67.6% were seropositive in 129 patients with different malignancies in Hospital Universiti Kebangsaan Malaysia (HUKM) (Nimir *et al.*, 2010), 42.5% were seropositive in 219 pregnant women who visited University Malaya Medical Centre (UMMC) (Hemah *et al.*, 2014) and among the Orang Asli communities in peninsular Malaysia, seropositivity of *Toxoplasma* antibodies was 37.0% out of 495 participants (Ngui *et al.*, 2011). However, congenital toxoplasmosis was found to be low among congenitally defective children, 0.4% in 1,060 patients (Tan & Mak, 1985) and 2% positive rate for congenital toxoplasmosis in a study done by Nissapatorn and Abdullah (2004).

Studies on toxoplamosis in HIV/AIDS patients in Malaysia were comprehensive. Seropositivity of toxoplasmosis ranged from 41.2% to 57.9% (Nissapatorn *et al.*, 2003; 2004; 2007). In 124 infected patients, highest seroprevalence was found in Malays (57.9%) compared to Chinese (38.7%) and Indians (29.6%) (Nissapatorn *et al.*, 2003). Of the 51.2% (208/406) seropositive patients, 21 patients were diagnosed with active toxoplasmic encephalitis (TE) based on the clinical observation (Nissapatorn *et al.*, 2003). All these patients were recruited from HIV/AIDS patients who visited Hospital Kuala Lumpur (HKL).

Yet, no studies on toxoplasmosis have been established among prison inmates. The present study was the first in Malaysia to determine the current trend and possible risk factors of *T. gondii* infection in HIV and non-HIV from this population in terms of socio-demographic and behavioural characteristics, clinical presentations and haematological distributions. This study would be beneficial in providing baseline information and enhancing understanding of toxoplasmosis for the implementation of better management and treatment for this population. Furthermore, this study helps in improving the knowledge and updates on toxoplasmosis among HIV patients in Malaysia.

MATERIALS AND METHODS

Study Design and Setting

A seroprevalence study was conducted involving the prison inmates, highlighting the association and comparison of toxoplasmosis in HIV infected and non-HIV infected groups. Three hundred and three (303) qualified participants comprising 133 HIV and 170 non-HIV individuals were serologically tested and compared for the presence of anti-*T. gondii* antibodies. Data on socio-demographic information, behavioural characteristics and clinical presentation using questionnaires were gathered to analyse the predisposing factors for *T. gondii* infection. Study duration was from June 2012 to January 2013.

Ethical Considerations

Ethical approval was obtained prior to the commencement of this study from the Ethics Committee of the University of Malaya Medical Centre, Malaysia (UMMC; reference no. 890.10). Once approved, a briefing on the objectives and methodology of the study was presented to the institution's Committee Board before an official approval letter was given.

Study Population and Sampling

An oral briefing to describe the objectives and methodology of the study was given to the participants by the investigator prior to sample collection. Informed consent was taken either in written form (signed) or verbally followed by thumb prints (for those who are illiterate) from each subject who voluntarily participated after a clear explanation of the research objectives. Three hundred and fourteen (314) participants gave their consent. Of these, only 303 participants fulfilled the inclusion criteria which included consented participants who provided both answered questionnaires and blood samples. From 303 subjects, 133 were identified to be HIV positive and 170 were HIV negative. After participants' consent were obtained and questionnaires were completed, approximately 5 ml of venous blood sample was drawn from each qualified participant by a

trained doctor. Each blood sample collected was distributed into 2 different tubes: (i) Becton Dickinson Vacutainer K2 EDTA tube (with ethylene diamine tetraacetic acid anticoagulant) and (ii) plain tube (without anticoagulant). Two mls of each blood sample in plain tubes were centrifuged at 1500 rpm for 10 minutes and the sera were kept at -20°C until further used. Blood in EDTA tubes were sent to Clinical Diagnostic Lab (CDL) University Malaya Medical Centre (UMMC), Kuala Lumpur for further analysis within 3 to 10 hours after blood collection.

Data Collection

A set of questionnaires were distributed to gather information on socio-demographic, behavioural characteristics and clinical presentations. Socio-demographic data included nationality, age, marital status, education attainment, occupation before being incarcerated, duration of incarceration and history of blood transfusion or organ transplant. History of drug abuse and sexual practice were obtained for behavioural characteristics. Clinical features such as the presence of flu like symptoms (i.e. fever, diarrhoea) and other diseases such as tuberculosis, hepatitis B or C and schizophrenia were asked. HIV positive subjects were also asked for information on duration of having HIV and access to HAART treatment. CD4 count was retrieved from the institution's clinic.

Serological detection of T. gondii antibodies

The sera obtained were subjected to ELISA for detection and quantitative determination of *Toxoplasma* IgM antibody (Trinity Biotech Captia™ *Toxoplasma gondii* IgM ELISA) and *Toxoplasma* IgG antibody (Trinity Biotech CaptiaTM *Toxoplasma gondii* IgG ELISA) towards *Toxoplasma* antigen coated on the solid phase according to the manufacturer's protocol. In both assays, ISR (Immune Status Ratio) value of more than 1.10 indicates presence of detectable antibody to *T. gondii*. Seropositive samples for only *Toxoplasma* IgM or both *Toxoplasma* IgM and IgG were further tested with Novalisa *Toxoplasma gondii* IgG avidity test (Novatec Immun-diagnostica GMBH) to rule out acute from latent infections. A high avidity test (> 40%) result excludes a recently acquired infection within 4 months of serum sampling (Chiang *et al*., 2014). *Toxoplasma* antibodies with low avidity (≤ 40%) indicates acute or recent infection.

Complete Blood Count (CBC) and Differential Count Analysis

These tests were carried out at the Clinical Diagnostic Laboratory (CDL), University Malaya Medical Centre, KL (Malaysia). Blood in EDTA tube was used for complete blood count and differential count analysis.

Data Analyses

Prevalence of *T. gondii* infection was presented in frequencies and percentages. SPSS software (Statistical Package for the Social Sciences) program for Windows version 22 (SPSS, Chicago, IL, USA) was employed for data entry and statistical analysis. Statistical significance of differences in proportions was evaluated by Chi-Square test and Fisher exact test (when values were less than 5) with significant value of $p < 0.05$ used for all tests. Univariate analysis was run to determine the association of *T. gondii* seropositivity with the variables from the questionnaires. Association of haematological distribution with *T. gondii* seropositivity was analysed using Mann-Whitney U test. $p < 0.05$ is the cut-off for a value to be considered as significant.

RESULTS

Overall seroprevalence of anti-*T. gondii* antibodies was detected in 41.9% (127 out of 303) of the participants. Of these, 93.7% (119 out of 127) subjects have IgG antibodies towards *T. gondii* and 6.30% (8 out of 127) subjects have IgM antibodies towards *T. gondii* in their serum. No seropositivity for both IgM and IgG were present among the subjects. Anti-*T. gondii* antibodies were detected in 63.2% (84 out of 133) HIV positive subjects and in 25.3% (43 out of 170) of HIV negative subjects. Seroprevalence of anti-*T. gondii* antibodies was significantly higher in HIV positive than in HIV negative subjects

(OR = 5.06; 95% CI = 3.09-8.30; p < 0.001). Of the 84 anti-*T. gondii* positive HIV subjects, 2 (2.4%) have IgM antibodies with 1 subject being in prison less than 4 months. IgG antibodies was encountered in 82 (97.6%) HIV positive subjects. In HIV negative subjects, 6 out of 43 (14.0%) had the presence of anti-*T. gondii* IgM antibodies. Only 2 subjects were being in prison less than 4 months. Whilst, IgG antibodies were encountered in 37 (86.0%) seropositive subjects in the non-HIV groups. Avidity test on serum positive for IgM showed that all the subjects did not have acute toxoplasmosis (infections within 4 months) as all 8 samples had avidity levels of > 40 per cent.

With respect to the association of socio-demographic and behavioural characteristics with the overall seroprevalence of *T. gondii* infection (Table 1), three characteristics had p values < 0.05: age group, HIV status and drug abuse history. Those in age group 40 years and above had higher infections (50.0%; 58/116) and odds

Table 1. Association of sociodemographic and behavioural characteristics with overall seroprevalence of *T. gondii* infections

Sociodemographic characteristics	Subject tested No.	Prevalence of *T. gondii* infection No.	%	OR (95% CI)	p value
Nationality					
Non-Malaysian	7	5	71.4	3.57 (0.68-18.68)	0.134[a]
Malaysian	296	122	41.2	1	
Age group (years)					
≥ 40	116	58	50.0	1.71 (1.07-2.74)	< 0.05
< 40	187	69	36.9	1	
Marital status					
Single/ Divorced/Widowed	224	98	43.8	1.34 (0.79-2.27)	0.275
Married/Living together	79	29	36.7	1	
Education attainment					
Primary school and below	83	38	45.8	1.24 (0.75-2.07)	0.402
Secondary school and above	220	89	40.5	1	
Occupation before incarcerated					
Laborer	252	103	40.9	0.78 (0.43-1.42)	0.414
Non-laborer	51	24	47.1	1	
Duration of incarceration (months)					
≤ 4 months and below	190	85	44.7	1.37 (0.85-2.21)	0.197
> 4 months and above	113	42	37.2	1	
Blood transfusion history					
Yes	44	21	47.7	1.32 (0.69-2.50)	0.398
No	259	106	40.9	1	
HIV status					
Positive	133	84	63.2	5.06 (3.09-8.30)	< 0.001
Negative	170	43	25.3	1	
Behavioural characteristics					
Drug abuse					
Yes	138	84	60.9	4.48 (2.75-7.32)	< 0.001
No	163	42	25.8	1	
Sexual practice					
> one partner	76	39	51.3	1.48 (0.85-2.58)	0.162
Single partner	154	64	41.6	1	

OR = Odd ratio, CI = Confidence interval
* tested by the Fisher exact test, others tested by the chi-square test

(OR = 1.71; 95% CI = 1.07-2.74) in acquiring toxoplasmosis than those in age group 40 years and below (36.9%; 69/187). HIV positive status appeared to favour the presence of *T. gondii* with 63.2% (84/133) being infected compared to the 25.3% (43/170) in those who were HIV negative (OR = 5.06; 95% CI = 3.09-8.30). Seropositivity for toxoplasmosis in those with drug abuse history was more prevalent (60.9%; 84 out of 138) in comparison with those who did not have a history of drug abuse (25.8%; 42/163). Higher odds (OR = 4.48; 95% CI = 2.75-7.32) in acquiring toxoplamosis was also found in those with history of drug abuse. There were 301 subjects who were willing to reveal their drug abuse history, another 2 decided not to disclose. Non-Malaysian had higher prevalence (71.4%; 5/7) and odds (OR = 3.57; 95% CI = 0.68-18.68) in having *T. gondii* infections than Malaysian, however it was not statistically significant. For sexual practice, only 230 disclosed their sexual behaviour, the rest were not willing to disclose or they never had sex before. Characteristics such as water sources and food handling were standardized among the subjects inside the institution, thus cannot be analysed by Chi-Square test. All subjects practised washing hands before eating and subjects history of contact with cat was not known.

Risk factors for *T. gondii* seropositivity in HIV positive subjects are shown in Table 2. However, none of the variables appeared to be significant. Analysis of risk factors for *T. gondii* seropositivity in HIV negative subjects was also attempted and tabulated in Table 3. Those with history of drug abuse had higher *T. gondii* occurrence with 46.2% (12/26) and was significantly associated ($p < 0.05$; OR = 3.12; 95% CI = 1.31-7.44) with the presence of *T. gondii* infections than those who did not have drug abuse history (21.5%; 31/144). Those incarcerated less than 4 months were also significantly associated with increasing rate of *Toxoplasma* ($p < 0.05$; OR = 3.13; 95% CI = 1.35-7.30). Thirty-five (32.1%) of those incarcerated less than 4 months were infected compared to 8 (13.1%) incarcerated more than 4 months. Non-Malaysian (OR = 3.00; 95% CI = 0.18-49.03), those within age group 40 years old and above (OR = 1.63; 95% CI = 0.80-3.32) and those with primary education and below (OR = 1.53; 95% CI = 0.73-3.21) had higher odds in getting toxoplasmosis. However, these results were not statistically significant.

Clinical presentation such as flu-like symptoms, having tuberculosis or hepatitis B/C and schizophrenia were not associated with *T. gondii* infections in the present study (Table 4). Haematology results of *Toxoplasma* infected and non-infected subjects are shown in Table 5. Mean for all parameters among the infected and non-infected individuals fall within the normal range (data not shown). However, it was observed that there was significant decrease in white blood cell count, neutrophils count and basophils count in those infected with *T. gondii* compared to those without *T. gondii* infection ($p < 0.05$) based on the mean rank when analysed using Mann-Whitney U test (Table 5). Out of 303 samples, 2 samples cannot be analysed for the haematological distributions due to clotting of blood samples.

DISCUSSION

Overall seroprevalence found in the present study was 41.9%, which is comparable with the seropositivity in general population in Malaysia. A study on toxoplasmosis in a similar setting was performed by Yaman *et al.* (2009) where two hundred and thirty six (37.58%) prisoners in Kayseri Closed Prison had anti-*T. gondii* IgG seropositive and 11 (1.75%) were both IgG and IgM seropositive. Alvarado-Esquivel *et al.* (2014) also reported seroprevalence of anti-*T. gondii* IgG antibodies was significantly higher in inmates (35, 21.1%) than in controls (14, 8.4%) (OR = 2.90; 95% CI: 1.43–5.94; $p = 0.001$). Anti-*T. gondii* IgM antibodies were detected in two (1.2%) inmates and in seven (4.2%) controls ($p = 0.17$) from this study. This study was done in the state correctional facility in Durango City, Mexico.

The seroprevalence of anti-*T. gondii* antibodies was significantly higher in HIV (63.2%) positive than in HIV negative subjects (25.3%) (OR = 5.06; 95% CI = 3.09-8.30; $p < 0.001$). This was in concordance with the

Table 2. Risk factors for *T. gondii* seroprevalence in HIV positive subjects

Sociodemographic characteristics	Subject tested No.	Prevalence of *T. gondii* infection No.	%	OR (95% CI)	p value
Nationality					
Non-Malaysian	5	4	80.0	2.40 (0.26-22.11)	0.651*
Malaysian	128	80	62.5	1	
Age group (years)					
≥ 40	59	40	67.8	1.44 (0.70-2.94)	0.322
< 40	74	44	59.5	1	
Marital status					
Single/ Divorced/Widowed	112	70	62.5	0.83 (0.311-2.23)	0.716
Married/Living together	21	14	66.7	1	
Education attainment					
Primary school and below	35	23	65.7	1.16 (0.52-2.61)	0.715
Secondary school and above	98	62	62.2	1	
Occupation before incarcerated					
Unemployed	23	15	65.2	1.11 (0.44-2.86)	0.822
Employed	110	69	62.7	1	
Duration of incarceration (months)					
≤ 4 months and below	81	50	61.7	0.85 (0.41-1.77)	0.670
> 4 months and above	52	34	65.4	1	
Blood transfusion history					
Yes	24	16	66.7	1.21 (0.47-3.07)	0.694
No	109	68	62.4	1	
Behavioural characteristics					
Drug abuse					
Yes	112	72	64.3	1.31 (0.48-3.52)	0.593
No	19	11	57.9	1	
Sexual practice					
> one partner	45	29	64.4	1.26 (0.57-2.80)	0.571
Single partner	61	36	59.0	1	
Duration of having HIV (years)					
≤ 10	89	57	64.0	1.12 (0.53-2.36)	0.763
> 10	44	27	61.4	1	
HAART					
No	125	80	64.0	1.78 (0.42-7.45)	0.466*
Yes	8	4	50.0	1	
CD4 count (cells/mm^3)					
≤ 200	24	12	50.0	0.57 (0.22-1.44)	0.228
> 200	72	46	63.9	1	

OR = Odd ratio, CI = Confidence interval, HAART = Highly active antiretroviral therapy
*tested by the Fisher exact test, others tested by the Chi-square test

study by Shamilah *et al.* (2001) which reported an overall prevalence of 26.3% with a significantly higher prevalence in HIV-positive (31.3%) compared with HIV-negative (24.3%) patients. *T. gondii* is an important opportunistic parasitic infection in HIV positive individuals. The prevalence rates of *Toxoplasma* infections in HIV-infected patients in Malaysia have been found to vary greatly from 20% to 60% (Nissapatorn *et al.*, 2002, Yoong & Cheong, 1997).

Classic serological test (detection of *T. gondii*-specific antibodies) is the most common approach used to detect toxo-

Table 3. Risk factors for *T. gondii* seroprevalence in HIV negative subjects

Sociodemographic characteristics	Subject tested No.	Prevalence of *T. gondii* infection No.	%	OR (95% CI)	p value
Nationality					
Non-Malaysian	2	1	50.0	3.00 (0.18-49.03)	0.443*
Malaysian	168	42	25.0	1	
Age group (years)					
≥ 40	57	18	31.6	1.63 (0.80-3.32)	0.181
< 40	113	25	22.1	1	
Marital status					
Single/ Divorced/Widowed	112	28	25.0	0.96 (0.46-1.98)	0.902
Married/Living together	58	15	25.9	1	
Education attainment					
Primary school and below	48	15	31.3	1.53 (0.73-3.21)	0.262
Secondary school and above	122	28	23.0	1	
Occupation before incarcerated					
Laborer	142	34	23.9	0.67 (0.28-1.61)	0.362
Non-laborer	28	9	32.1	1	
Duration of incarceration (months)					
≤ 4 months and below	109	35	32.1	3.13 (1.35-7.30)	< 0.05
> 4 months and above	61	8	13.1	1	
Blood transfusion history					
Yes	20	5	25.0	0.98 (0.34-2.88)	0.974*
No	150	38	25.3	1	
Behavioural characteristics					
Drug abuse					
Yes	26	12	46.2	3.12 (1.31-7.44)	< 0.05
No	144	31	21.5	1	
Sexual practice					
> one partner	31	10	32.3	1.11 (0.46-2.65)	0.822
Single partner	93	28	30.1	1	

OR = Odd ratio, CI = Confidence interval
*tested by the Fisher exact test, others tested by the chi-square test

plasmosis. Unfortunately, it is not a reliable tool to distinguish recent (acute) from past infection. IgM antibodies towards *Toxoplasma* may persist for months or even years following primary infection (Bobic *et al.*, 1991; Del Bono *et al.*, 1989). Thus, acute toxoplasmosis cannot solely be confirmed by the presence of *T. gondii*-specific IgM. Measurement of *T. gondii*-specific IgG avidity has proven to be a powerful tool for discriminating recently acquired from distant (past) toxoplasmosis (Chiang *et al.*, 2014; Abolghasem *et al.*, 2011; Liesenfeld *et al.*, 2011). A high avidity test result observed in this study excluded a recently acquired infection within 3/4/5/6 months of serum sampling (depending on manufacturer's protocol). Infection with *T. gondii* during pregnancy may lead to severe consequence in the fetus (Remington and Klein, 1995) and antibiotic treatment should be considered. If the infection occurred before pregnancy, the fetus is protected against congenital toxoplasmosis. Avidity test is usually performed on women in early pregnancy with detectable *T. gondii*-specific IgM antibodies to distinguish between these two possibilities. The reason for performing avidity test in the present study was to determine the approximate time of *Toxoplasma* infection; whether they were infected during or before incarceration. High avidity results were

Table 4. Association of overall *T. gondii* seroprevalence with clinical presentations and presence of disease

Clinical presentations	Subject tested No.	Prevalence of *T. gondii* infection No.	%	p value
Flu-like symptoms				
Yes	239	94	39.3	0.78
No	64	33	51.6	
Diseases present				
Tuberculosis				
Yes	20	6	30.0	0.264
No	283	121	42.8	
Hepatitis B or C				
Yes	22	10	45.5	0.727
No	281	117	41.6	
Schizophrenia				
Yes	6	3	50.0	0.698*
No	297	124	41.8	

Table 5. Haematological distributions (mean rank) in *Toxoplasma* infected and non-infected subjects

Paramaters	Infected	Non-infected	p value
Blood count			
Hb	142.31	157.17	0.144
RBC	145.98	154.57	0.399
WBC	138.49	159.88	0.036[a]
Differential count			
Neutrophils	132.89	163.86	0.002[a]
Lymphocytes	149.88	151.80	0.850
Monocytes	155.18	148.03	0.482
Eosinophils	150.97	151.02	0.996
Basophils	134.79	162.51	0.006[a]

[a] Indicates significant difference ($p < 0.05$)

reported for all 8 samples tested, implicating the possibility of *Toxoplasma* infection before incarceration.

In the present study, age group 40 years and above, HIV positive status and history of drug abuse were predictive factors for *Toxoplasma* seropositivity. Majority of the previous local studies (Tan & Zaman, 1973; Nissapatorn *et al.*, 2003a) and foreign studies (Yohanes *et al.*, 2014; Shin *et al.*, 2009) have described that *Toxoplasma* infection tended to increase with age, which is in accordance with the present study. *Toxoplasma* is the most important parasitic opportunistic infection (POI) associated with HIV-infected patients, which has been widely reported. High prevalent rates of latent toxoplasmosis were reported in South America (41.9-72%) and half of the studies were in Asian continent (≥ 40%) (Nissapatorn & Sawangjaroen, 2011). Same trend was observed in the present study with high prevalence of *T. gondii* seropositivity (41.9%). HIV positive status was significantly associated with the

presence of *T. gondii*. Walle *et al.* (2013) also stated a higher seroprevalence of anti-*T. gondii* antibodies in HIV infected pre-ART compared to non-HIV infected (healthy blood donors) in Bahir Dar, Northwest Ethiopia. Overall *T. gondii* seropositivity had significant increase in those with drug abuse history in present study. Univariate analysis on risk factors among HIV negative subjects also reported the same trend. Practice of sharing needle contaminated with blood of *Toxoplasma* carrier among the drug abusers may have contributed to the risk of acquiring toxoplasmosis. Study by Alvarado-Esquivel *et al.* (2014) on the risk factors of *T. gondii* infections showed drug abusers have higher seroprevalence of *T. gondii* than those who are not, although it is not statistically significant.

Those incarcerated within 4 months and less was significantly associated with the increased rate of *T. gondii* infection in non-HIV group. It shows the high probability of acquiring *Toxoplasma* before they were incarcerated. Chances of exposure to toxoplasmosis before incarceration would depend on their eating habits, lifestyle, close proximity with cats, occupational and socioeconomic status. Water sources, food handling and preparation inside the institution were standardized and they did not have any contact with cats.

Neutrophils and basophils are the major types of white blood cells. These cells help human body in fighting infections. Significant decrease in white blood cell (WBC) count, neutrophils count and basophils count were observed in those infected with *T. gondii* compared to those without *T. gondii* infections ($p < 0.05$). Lower neutrophils count in those infected with *T. gondii* compared to non-infected individuals in present study were in alignment with Shahzad *et al.* (2006). Acute toxoplasma infection may decrease the WBC count due to parasite invasion of the bone marrow (Remington *et al.*, 2001), resulting in the inefficiency of bone marrow to produce WBC. However, *Toxoplasma* infection in the present study were latent and more than 4 months, thus it could not be indicated as the reason for these observations. Other conditions such as HIV infection, presence of tuberculosis and hepatitis B or C may have contributed to these apparent conditions.

CONCLUSION

In conclusion, overall seroprevalence of latent *T. gondii* infection was high among the participants with 41.9% of 303 participants. *T. gondii* seropositivity was significantly higher in HIV positive participants compared to non-HIV. The rate of *T. gondii* seropositivity significantly increased in those aged 40 years and above, HIV positive individuals and those with history of drug abuse. WBCs and differential counts of neutrophils and basophils counts were significantly decreased in those infected with *Toxoplasma*. Latent toxoplasmosis in HIV-infected individuals may undergo reactivation leading to the development of toxoplasmic encephalitis (TE). TE is the most common clinical presentation of toxoplasmosis which complicates AIDS (Nissapatorn *et al.*, 2004) and poses many diagnostic and therapeutic challenges for clinicians (Israeski & Remington, 1992). Creating awareness about *T. gondii* infection and follow-up of their status is recommended. Moreover, screening of *T. gondii* infection in HIV-infected individuals should be considered for better treatment and management, including control and prevention.

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