PREVALENCE OF *TOXOPLASMA GONDII* IGG AND IGM AND ASSOCIATED RISK FACTORS AMONG HIV-POSITIVE AND HIV-NEGATIVE PATIENTS IN VHEMBE DISTRICT OF SOUTH AFRICA

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Abstract

Background: *Toxoplasma gondii* is a zoonotic parasite that has arisen as an important opportunistic infection that causes morbidity and mortality especially in HIV positive patients. This study was carried out to determine the sero-prevalence of *T. gondii* (IgG and IgM) and the associated risk factors among HIV positive and negative patients in Northern South Africa.
Materials and Methods: The study was conducted in the Vhembe District in Limpopo province from April 2012 to January 2013. A well-structured questionnaire was used to collect socio-demographic information and possible risk factor information on toxoplasmosis from participants. A total of 161 blood samples of both HIV positive and negative patients visiting the local clinics in the Vhembe district were collected. Serum samples were tested for IgG and IgM against *T. gondii* using commercially available ELISA protocol.
Results: The prevalence of *T. gondii* IgG was 31.7% while that of *T. gondii* IgM was 4.9%. The prevalence of *T. gondii* IgG was higher in HIV positive patients (38%) compared to 16.7% among HIV negative patients (p=0.001). *Toxoplasma gondii* IgG antibodies were more common in patients who were not taking ARV's (46.2%) compared to those who were taking ARV's (35.2%) (P<0.001).
Conclusions: The present study has shown a high prevalence of *T. gondii* (IgG) among patients attending different HIV clinics in the Vhembe district with no current infections among pregnant women. In addition to the sero-positive status of the patient to HIV, other significant risk factors for toxoplasmosis included high viral load, non-adherence to ARV therapy and age (>25 years).

Keywords: ELISA, HIV, *Toxoplasma gondii,* Sero-prevalence, Opportunistic infections.

Introduction

Toxoplasma gondii is a zoonotic intracellular parasite that causes the disease toxoplasmosis (Kopecna et al., 2006). The infection is very common in humans around the world (Lim and Othman, 2014). In immuno-competent individuals, the symptoms may be mild or remain asymptomatic while it causes high rates of morbidity and mortality in immunocompromised individuals (Shen et al., 2016). Toxoplasmosis is one of the most important opportunistic infections detected in HIV patients. According to the U.S centres for disease control and prevention, Toxoplasmosis is an AIDS-defining illness. In HIV infection, toxoplasmic encephalitis occurs due to reactivation of latent *Toxoplasma* infection (Daryani et al., 2011). However, the epidemiology of toxoplasmosis is not clearly understood in the Northern region of South Africa.

The prevalence of toxoplasmosis varies between regions and is higher in areas where cats are common (Prestrud et al., 2010; Dubey et al., 2016). In South Africa, Harri et al. (2007) reported a prevalence of 8% infection with *T. gondii* among HIV patients in Johannesburg, whereas another study in the Limpopo province, north of the country, reported a higher prevalence (18.1%) among chronically ill HIV patients (Bessong and Mathomu, 2010). However, both studies did not test for IgM antibodies. In Brazil, the prevalence of *Toxplasma* IgG was 16% among pregnant women while that of IgM was 1% in the same population (de Quadros et al., 2015). Moreover, in an Ethiopian study, the seroprevalence was found to be 60% and 64% in females and males respectively (Negash et al., 2008). However, they also did not test for *T. gondii* IgM antibodies.

Exposure to Toxoplasma is shown by the detection of Toxoplasma IgG while IgM indicates current infections (Gashout et al., 2016). These infections might be more relevant as they indicate the level of epidemic in a specific community. Current infections among pregnant women are dangerous and could lead to malformation of the newborn or its death (Dubey et al., 2016). Although previous studies have shown that the prevalence of Toxoplasma IgG in South Africa varies between 8% and 16%, very few studies have reported on the prevalence of current infections particularly in the

northern part of South Africa. Therefore, the present study sought to determine *T. gondii* IgG and IgM seroprevalence among patients visiting the HIV clinics in the Vhembe region and to identify factors that might be associated with *T. gondii* in the region.

Materials and Methods
Study participants and design

The study was a cross sectional survey of patients visiting HIV clinics at different hospitals in the region and the University of Venda. It was conducted in the Vhembe district in Limpopo province from April 2012 to January 2013. A well-structured questionnaire was used to collect socio-demographic information and possible risk factor information on toxoplasmosis from participants. A total of 161 blood samples were collected from HIV positive (118) and negative (43) patients from the three main hospitals in the Vhembe district, Limpopo Province (Elim, Donald Fraser and Tshilidzini). Some of the samples were collected from the students attending the University of Venda. The samples were transported in cooler boxes filled with ice to the laboratory of Microbiology at the University of Venda for further analysis. Plasma was obtained following centrifugation of blood samples and stored at -20°c until further use.

Serological testing for toxoplasmosis

The presence of *T. gondii* IgG and IgM antibodies in the serum samples was determined by the ELISA method. The test was done using the bioelisa TOXO IgG and TOXO IgM kits (BIOKIT, S.A, Barcelona- Spain) as per the manufacturer's instructions. The optical densities (OD) values were read using ELISA reader (Bio-Tek INSTRUMENTS, INC) at 450nm and the results were recorded.

Ethical considerations

The health and ethics committee of the University of Venda approved the study. Ethical clearance was also obtained from the different hospitals where the samples were collected. The objectives of the study were clearly explained to the sample providers and they were requested to sign the consent forms before data and sample collection. The information obtained from the patients was kept confidential.

Statistical analysis

The data obtained was analysed using SPSS version 18.1. The chi square test was used for all analysis comparing the prevalence of toxoplamosis among the patients according to different demographic characteristics as well as different potential risk factors. The difference was considered significant if the p value was less than 0.05.

Results
Socio- demographic and clinical characteristics of the study population

Most of the patients tested for Toxoplasma antibodies in the present study, were HIV positive 118 (73.3%) while 34 (26.7%) were HIV negative. Most of them were from Donald Fraser (41%), and 64% of the patients were females [Table 1].

Table 1: Demographic characteristics of the study population

Characteristics		Frequency	Percent
HIV status	HIV negative	43	26.7
	HIV positive	118	73.3
Hospital	Donald Fraser	66	41.0
	Elim	12	7.5
	LTT	15	9.3
	Tshilidzini	25	15.5
	Univen	43	26.7
Age group	Less than 25 years	39	26.5
	25 years- 45 years	65	44.2

	Above 45 years	43	29.3
Gender	Male	54	36.0
	Female	96	64.0
Marital Status	Single	81	54.0
	Married	49	32.7
	Divorced	8	5.3

The occurrence of *T. gondii* IgG in patients in relation to HIV status, place of infection, hospitals, age, gender and marital status of the patients.

The antibodies (IgG) against *T. gondii* were more common in HIV infected patients (38%) compared to HIV negative patients (16.7%) and the difference was statistically significant (χ^2=6.218, p= 0.013). Patients recruited at Elim hospital had a higher prevalence (54.5%) compared to other hospitals and University of Venda students had the least prevalence among all the sites. The antibodies (IgG) against *T. gondii* were more detected in patients aged above 45, and the least prevalence was found in patients aged 25 or less. In terms of gender, the infection was more commonly detected in females (34.1%) than in males (29.8%) and the difference was not statistically significant. The infection was more common among patients who indicated that they had obtained the HIV infection in the Vhembe district (42.0%) compared to those infected in other places (27.3%) but the difference was not statistically significant (p>0.05) (Table 2). There was no difference in the prevalence of IgG among patients receiving prophylaxis and those who were not receiving prophylaxis.

Table 2: The occurrence of *T. gondii* IgG in patients in relation to HIV status, place of infection, hospitals, age, gender and marital status of the patients.

Variables	Characteristics	Toxo IgG Positive	Total	Statistics (χ^2, p)
HIV status	HIV negative	7 (16.7%)	42	χ^2=6.218, p=0.013
	HIV positive	38 (38%)	100	
Hospital	Donald Fraser	22(40.0%)	55	χ^2= 8.963, p=0.062
	Elim	6 (54.5%)	11	
	LTT	4 (26.7%)	15	
	Tshilidzini	6 (31.6%)	19	
	Univen	7 (16.7%)	42	
Agegroup3	25 or less	6 (16.2%)	37	χ^2=7.425, p=0.024
	25- 45	20 (35.1%)	57	
	Above 45	16 (45.7%)	35	
Gender	Male	14 (29.8%)	47	χ^2=0.258, p=0.611
	Female	29 (34.1%)	85	
Marital status	Single	21 (28.8%)	73	χ^2=1.258,p= 0.739
	Married	15 (35.7%)	42	
	Divorced	3 (42.9%)	7	
	Widowed	4 (40.0%)	10	
Infected in Vhembe	NO	3 (27.3%)	11	χ^2=0.871, p=0.351
	YES	34 (42.0%)	81	
Year of recruitment	2010	36 (43.6%)	104	χ^2=1.536, p= 0.215
	2011	9 (23.7%)	38	
WAZ less than -2	Not underweight	36 (30.5%)	118	χ^2=2.154, p=0.142
	Underweight	4(57.1%)	7	
Prophylaxis	NO	23 (38.3%)	60	χ^2=0.149, p=0.700
	YES	14 (42.4%)	33	

The occurrence of *T. gondii* -IgG in HIV patients in relation to ARV treatment and CD4 count

Toxoplasma gondii IgG antibodies were more common in patients who were not taking ARV's (46.2%)[Table 3]. No significant difference was observed between the CD4 level (less than 50) and T. gondii IgG titer. The seroprevalence of *Toxoplasma* IgG was much higher (58.3%) among patients with high viral load compared to those with low viral load (14.8%) (P=0.005) The patients using alternative medication were not highly infected (33.3%), compared to those who were not taking alternative medication (40.2%) although the difference was not significant. In terms of ARV's used by

these patients, tenofovir was found to be the best ARV because of the low Toxo sero-prevalence in people who were taking it (29.4%), compared to those using other ARV's, e. g stavudine, lamivudine, nevirapine and efavirenz.

Table 3: The occurrence of *T. gondii* IgG in HIV positive patients in relation to ARV treatment and the CD4 status of the patients

Variables	Characteristics	Toxo IgG Positive	Total	Statistics
ARV	NO	18(46.2%)	39	χ^2=1.137, p= 0.286
	YES	19 (35.2%)	54	
Have you stopped	NO	6 (33.3%)	18	
	YES	2(100.0%)	2	
CD4 less than 50	NO	29 (39.7%)	73	χ^2=0.007, p=0.932
	YES	5 (38.5%)	13	
CD4 count Less Than 200	NO	16 (37.2%)	43	χ^2=0.195, p=0.659
	YES	18 (41.9%)	43	
CD4 count more than 300	NO	25 (41.7%)	60	χ^2= 0.377, p=0.539
	YES	9 (34.6%)	26	
Viral load range	Low	4(14.8%)	27	χ^2=7.770,p=0.005
	High	7 (58.3%)	12	
Bactrim	NO	28 (38.9%)	72	χ^2= 0.107, P=0.744
	YES	9 (42.9%)	21	
Zidovudine	NO	17(34.7%)	49	χ^2= 0.056, P=0.813
	YES	2(40.0%)	5	
Efavirenz	NO	4 (33.3%)	12	χ^2= 0.023, P=0.870
	YES	15 (35.7%)	42	
Lamivudine	NO	0 (0.0	1	χ^2= 0.553, P=0.457
	YES	19(35.8%)	53	
Tenofovir	NO	14 (37.8%)	37	χ^2=0.363,P=0.547
	YES	5 (29.4%)	17	
Nevirapine	NO	15 (33.3%)	45	χ^2= 0.406, P=0.524
	YES	4(44.4%)	9	
Stavudine	NO	7 (31.8%)	22	χ^2=0.185, P=0.667
	YES	12 (37.5%)	32	

The prevalence of *T. gondii* IgG in patients in relation to animal ownership

Patients who admitted keeping animals in their households appeared to be less infected compared to those who did not keep animals in the house. *Toxoplasma gondii* IgG antibodies were more detected in patients who had dogs in their homes (40%) [Table 4].

Table 4: The prevalence of *T. gondii* IgG in patients who kept animals in the house

Variables	Characteristics	Toxo IgG Positive	Total	Statistics (x2, p)
Animals in house	NO	39 (34.5%)	113	χ^2=0.920, p=0.337
	YES	5 (23.8%)	21	
Chicken	NO	41(33.1%)	124	χ^2=0.538, p=0.463
	YES	3 (23.1%)	13	
Cattle	NO	43 (32.3%)	133	χ^2=0.096, p=0.757
	YES	1 (25.0%)	4	
Dogs	NO	42 (31.8%)	132	χ^2=0.148, p=0.701
	YES	2 (40.0%)	5	
Cats	NO	44 (32.4%)	13	χ^2=0.477, p=0.490
	YES	38(23.4%)	13	
Goats	NO	43 (32.3%)	133	χ^2=0.096, p=0.757
	YES	1(25.0%)	4	

The occurrence of *T. gondii* IgG among the patients in relation to water sources

The patients were using water from different sources; some patients were treating their water before use, while others were not. No statistically significant difference was noted between those using untreated water as opposed to the group of patients using treated water [Table 5]. *Toxoplasma gondii* IgG antibodies were higher in patients who were storing water for a long time (more than 5 days) than those who were storing water for less than 5 days. However, the difference was not statistically significant. [Table 5].

Table 5: The occurrence of *T. gondii* IgG in relation to the different water sources used

Variables	Characteristics	Toxo IgG Positive	Total	Statistics
Water source	Communal tap	31 (30.7%)	101	χ^2=1.159, p=0.763
	Tap in the house	9(39.1%)	23	
	River/Spring	2 (50.0%)	4	
	Borehole	2 (33.3%)	6	
Water storage	Two days or less	27 (31.0%)	87	χ^2=0.30, p=0.866
	3 to 5 days	7 (36.8%)	19	
	More than 5 days	9 (34.6%)	26	
Treated Source	NO	4 (40.0%)	10	χ^2=0.251, p=0.616
	YES	40 (32.3%)	124	
Do you treat water	YES	42 (32.1%)	131	χ^2=1.593, p=0.207
	NO	2 (66.7%)	3	

Overall *T. gondii* IgM seroprevalence in the study population

The seroprevalence of *T. gondii* IgM was much lower compared to that of the IgG at 4.9%. There was no significant difference between the seroprevalence of *T. gondii* IgM among HIV negative (7.1%) and positive individuals (3.9%) The infection with *T. gondii* was more detected in patients from UNIVEN (7.1%), LTT (6.7%) and Donald Fraser (5.8%), while those from Elim and Tshilidzini were seronegative (P=0.652) (Table 6). The patients in the age group 25 years or less, had a high prevalence (7.9%) compared to others in the age groups 26 to 45 years (3.6%) [Table 6]. The prevalence was higher in males compared to females and in terms of marital status the prevalence was found to be high in divorced patients (12.5%) and those who indicated that they were married had a prevalence of (4.8%). The patients who were infected in the Vhembe district had a lower prevalence (2.4%), than those who were infected from other places and the difference between these two variables was not statistically significant. There was no difference between the prevalence of *T. gondii* IgM among patients who were recruited in 2010 and 2011. Those who were underweight had a high prevalence of 12.5% compared to those who were not underweight (4.1%). In terms of prophylaxis, those who were receiving prophylaxis had a low prevalence compared to those who were not receiving.

Table 6: The occurrence of *T. gondii* IgM in HIV patients from different hospitals, place of infection, age groups, gender and marital status of patients.

Variables	Characteristics	Toxo IgM Positive	Total	Statistics
HIV status	Negative	3 (7.1%)	42	χ^2=0.668, p=0.414
	Positive	4 (3.9%)	102	
Hospital	Donald Fraser	3 (5.8%)	52	χ^2=2.460, p=0.652
	Elim	0 (0.0%)	10	
	LTT	1(6.7%)	15	
	Tshilidzini	0(0.0%)	25	
	Univen	3 (7.1%)	42	
Age group	25 or less	3 (7.9%)	38	χ^2=1.398, p=0.497
	25-45	2 (3.6%)	55	
	Above 45	1 (2.6%)	38	
Gender	Male	4 (8.0%)	50	χ^2=2.314, p=0.128
	Female	2 (2.4%)	84	
Marital status	Single	3 (4.0%)	75	χ^2= 1.674, p= 0.643
	Married	2(4.8%)	42	
	Divorced	1 (12.5%)	8	

	Widowed	0 (0.0%)	9	
Infected in Vhembe	NO	1 (11.1%)	9	χ^2= 1.985, p= 0.159
	YES	2 (2.4%)	84	
Year of recruitment	2010	5 (4.9%)	103	χ^2= 0.000, p= 0.995
	2011	2 (4.9%)	41	
WAZ-2	Not underweight	5(4.1%)	121	χ^2= 1.185, p= 0.276
	Under weight	1 (12.5%)	8	
Prophylaxis	NO	3 (4.8%)	62	χ^2= 1.599, p=0.206
	YES	0 (0.0%)	32	

The prevalence of *T. gondii* IgM in HIV patients taking ARV'S and the CD4 status of the study population

Toxoplasma gondii IgM was more prevalent in patients taking ARV's compared to those who were not on ARV's. Different types of ARV's were used by the patients on medications. These included: stavudine, lamivudine, tenofovir, efavirenz, tenofovir and nevirapine. Toxoplasma IgM antibodies were found to be high in patients who were not on ARV's than those who were adhering to treatment. *Toxoplasma gondii* IgM antibodies were not detected in patients using alternative medication and bactrim. While statistically insignificant, the Toxo-IgM seroprevalence was higher among patients whose CD4 was less than 50 cell/mm^3 (7.1%) compared to those who had a CD4 level more than 50 cells/mm3. No significant difference was observed between the CD4 level (less than 50) and *T. gondii* IgM titer [Table 7].

Table 7: The prevalence of *Toxoplasma gondii* (IgM) in HIV patients taking different ARV's and the CD4 status the patients.

Variables	Characteristics	Toxo IgM Positive	Total	Statistics
ARV	NO	1 (2.3%)	44	χ^2=0.226, p=0.635
	YES	2 (4.0%)	50	
Zidovudine	NO	1 (2.2%)	45	χ^2=2.932, p=0.087
	YES	1 (16.7%)	6	
Efavirenz	NO	1 (7.7%)	13	χ^2=0.658, p=0.417
	YES	1 (2.6%)	38	
Lamivudine	NO	0(0.0%)	2	χ^2=0.085, p=0.771
	YES	2 (4.1%)	49	
Tenofovir	NO	2(6.7%)	30	χ^2=1.457, p=0.227
	YES	0 (0.0%)	21	
Nevirapine	NO	1 (2.4%)	42	χ^2=1.499, p=0.221
	YES	1 (11.1%)	9	
Alternative medicine	NO	3 (3.3%)	91	χ^2= 0.102, p=0.749
	YES	0 (0.0%)	3	
Bactrim	NO	3 (4.0%)	75	χ^2=0.785, p=0.376
	YES	0 (0.0%)	19	
Diarrhea at ARV start	NO	2 (4.1%)	49	χ^2=0.127, p=0.721
	YES	0 (0.0%)	3	
CD4 less than 50	NO	1 (1.4%)	72	χ^2=1.708, p=0.191
	YES	1 (7.1%)	14	
CD4 count Less Than 200	NO	1 (2.3%)	43	χ^2=0.000, p=1.000
	YES	1 (2.3%)	43	
CD4 More than 300	NO	1 (1.7%)	58	χ^2=0.284, p=0.594
	YES	1(3.6%)	28	

The prevalence of *T. gondii* IgM in patients keeping domestic animals in the households

Toxoplasma gondii IgM antibodies were higher in patients keeping domestic animals in the households. The patients who had chickens were more infected than those who were not with no chickens. Moreover, patients who had goats and cattles had a higher prevalence of *T. gondii* IgM [Table 8].

Table 8: The prevalence of *T. gondii* IgM in patients who keep animals in their houses

Variables	Characteristics	Toxo IgM Positive	Total	Statistics
Animals in house	NO	5 (4.4%)	114	$\chi^2= 0.001$, p=0.973
	YES	1(4.5%)	22	
Chicken	NO	6 (4.8%)	125	$\chi^2= 0.205$, p=0.651
	YES	1(7.7%)	13	
Cattle	NO	6(4.5%)	133	$\chi^2=2.401$, p= 0.121
	YES	1(20.0%)	5	
Dogs	NO	6 (4.6%)	131	$\chi^2=1.300$, p=0.254
	YES	1 (14.3%)	7	
Cats	NO	7(5.1%)	138	
	YES	0	0	
Goats	NO	6 (4.5%)	134	$\chi^2=3.397$, p=0.065
	YES	1 (25.0%)	4	

The prevalence of *T. gondii* IgM in relation to water sources and the quality of water

In terms of water usage, the patients who were using water from rivers and streams were be more infected by *T. gondii* (33.3%). Furthermore, those who were using water from communal tap had a prevalence of 4.9% [Table 9]. No statistically significant difference was noted between those using tap water as opposed to the group of patients using water from the river/borehole. A high prevalence of *T. gondii* IgM antibodies was detected in patients using water from untreated source compared to the group of patients using water from treated sources (P=0.311). Very few patients were treating their water before use, about 4.5% of *T. gondii* IgM was detected in patients who were not treating their water and the difference was not statistically significant (p>0.05). In terms of water storage, the patients who stored water for 2 days or less appeared to be more infected (4.7%) and there was no difference between the prevalence of *T. gondii* among patients who stored water for 3 to 5 days and more than 5 days, the difference was also not statistically significant.

Table 9: The prevalence of *T. gondii* in relation to water source and the quality of water.

Variables	Characteristics	Toxo IgM Positive	Total	Statistics
Water source	Communal tap	5(4.9%)	102	$\chi^2=7.439$, p=0.311
	Tap in the house	0 (0.0%)	25	
	River/Spring	1 (33.3%)	3	
	Borehole	0(0.0%)	6	
Treated Source	NO	1(11.1%)	9	$\chi^2=1.026$, p=0.311
	YES	5 (3.9%)	127	
Do you treat water	NO	6 (4.5%)	134	$\chi^2=0.094$, p=0.760
	YES	0 (0.0%)	2	
Water storage	Two days or less	4 (4.7%)	85	$\chi^2=0.029$, p=0.986
	3 to 5 days	1 (4.2%)	24	
	More than 5 days	1 (4.0%)	25	

Discussion

Opportunistic infections, with reference to toxoplasmosis are common cause of serious health problems in immune-compromised patients, particularly those with HIV and AIDS (Schurer et al., 2016). In the present study, out of 142 (100 positive and 42 negative) subjects tested, 31.7% were sero-positive for Toxo- IgG antibodies and of the 144 samples tested, 4.9% were sero-positive for Toxo- IgM antibodies. Our study reported a higher prevalence of *T. gondii* IgG antibodies than the one reported by Bessong and Mathomu, (2010) and by Kistiah et al in (2011).

This study showed that prevalence of *T. gondii* IgG was higher in HIV positive patients and low in those who were taking ARVs indicating that the use of ARVs might have a positive effect on *T. gondii* infections. Similar results were found in Ethiopia where Muluye et al. (2013) also described a high prevalence of toxoplasma IgG among HIV and AIDS patients while the prevalence was lower among HIV negative participants.

It was also found that both IgG and IgM antibodies are elevated in patients with high viral load, which cause the body to be more susceptible to opportunistic infections. The IgM antibodies prevalence in the study population decreased with age. This shows a decline in the infection rate. Similar results were found in a study conducted by Bata et al. (2009). Their study showed a high prevalence in patients with age group between 36-45 years. Nijem and Al-Amleh (2009) also found the prevalence of toxoplasmosis to be increasing with age and similar results were obtained by another study by Rosso et al. (2008). It has been suggested that old people are more likely to have been exposed to any of the risk factors than younger people as a results of longer exposure time (Endalew et al., 2012)

Ingestion of contaminated meat or contact with infected animals (definitive hosts) are some of the risk factors of toxoplasmosis (Foroutan-Rad et al., 2016). People become infected after ingesting soil, water or plant material contaminated with oocysts. In the present study, many participants agreed that they had animals in their house, but Toxo IgG antibodies were less detected in patients who had animals compared to those who didn't have animals in the house. This is to show that most of the patients, who had past infection, probably did not get it from the animals, but about 40% of these antibodies were found in patients who had dogs, which might serve as one of the potential risks for toxoplasmosis. Similarly, a study in Sri Lanka indicated that animal ownership did not have a significant impact on the seroprevalence of *Toxoplasma* (Chandrasena et al., 2016). In a study in Spain, Cano-Terriza et al. (2016) found a high prevalence of *Toxoplasma* IgG in dogs and the prevalence was associated with the age of the dogs.

Toxoplasmosis is an important problem among pregnant women presenting the risk of infecting the new born child. Fortunately, in the present study, IgM positivity was absent among pregnant women. Similar results have been described by Capretti et al. (2014). Over the past five years there has been a significant decrease of toxoplasmosis among pregnant women. Similar results were described by Chandrasena et al. (2016). In a study conducted in Saudi Arabia by Elsafi et al., (2015), the seroprevalence of toxoplasma among pregnant women were 28% and 3% for IgG and IgM respectively while more than 75% of the women were unaware of the disease toxoplasmosis. Education of the community members is therefore very important for the implementation of safety measures to reduce infection levels. Contrary to the IgG, the IgM antibodies were more detected in patients who had animals in home. This may be an indication of the potential differences in the prevalence of exposure to toxoplasmosis and current infection trends. It is possible that people who had the animals were at a much higher high risk of current toxoplasmosis. High IgM antibodies were detected in patients who had goats, cattle and the seroprevalence rate decreased among those who had dogs. A study in Mexico found a high seroprevalence of *T. gondii* in dogs (Cedillo-Peláez et al., 2012). These results suggest that most of the people who are infected are those who come into contact with dogs, cattles and goats. This study also showed that Toxoplasmosis is associated with low hygiene, considering its potential transmission by water and food which have been identified as important risk factors for the transmission of toxoplasmosis (Pereira et al., 2010). The severity of the infection differs among patients depending on host's immune status and genotypes. Further studies are needed to determine the circulating genotypes in the study population.

Conclusion

Toxoplasmosis is prevalent in the study population. This study has shown that sero-positive status of the patient to HIV, high viral load, non-adherence to ARV therapy, age (>25 years) and the presence of infected animals such as dogs, cattle and goats are the significant risk factors for toxoplasmosis in this study population. Therefore, people should be educated about toxoplasmosis prevention.

Acknowledgements

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