

The Impacts of Latent Toxoplasmosis on Physical Violent Actions among a Sample of Jordanian Inmates

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Abstract: The present study was conducted in the light of the fact that latent toxoplasmosis has been associated with certain neurological conditions including encephalitis as well as behavioral disturbances including physical violent actions among which is suicidal behaviors. The objectives of this study were to determine the prevalence of seropositivity of IgG and IgM of *T. gondii* among prisoners with physical violence and to associate toxoplasmosis with predictors including demographic variables. Study methodology involved collecting a cross sectional survey data from participants. Blood samples were collected from inmates as the study group to analyze samples for *T. gondii* IgG and IgM. Study sample included 302 arrested persons for physical violent actions in addition to 200 participants from normal population as a reference group. Study findings showed that the level of IgG was significantly higher in study group than control group ($p = 0.003$). The level of *T. gondii* IgM was significantly higher in control group compared with study group ($p = 0.000$). No significant associations were observed between either *T. gondii* IgG or IgM with other study variables. Taken together, the results of the present study confirmed other previous studies in which latent toxoplasmosis is significantly associated with violent behaviors. Our findings showed a significant difference in *T. gondii* IgG level among study group and control group. The same trend was observed for *T. gondii* IgM.

Key words: Latent toxoplasmosis, *Toxoplasma gondii*, *T. gondii* IgG, *T. gondii* IgM, violence

INTRODUCTION

Toxoplasma gondii (*T. gondii*) causes infectious disease called toxoplasmosis which in turn is considered a significant etiologic agent of encephalitis, retinitis and myocarditis (Hill and Dubey, 2002; Blader and Saeij, 2009; Lilly and Wortham, 2013). Furthermore, toxoplasmosis has particular importance in cases involving immuno-compromised patients because it is an important cause for hospitalization and death (Jones and Roberts, 2012).

According to study by Brundin *et al.* (2015), *T. gondii* is one of neurotrophic pathogens that are characterized with low virulence and residing within the CNS of immuno-competent hosts after infection.

Several studies have shown that chronic, low-grade infections can induce effects on the host brain. Studies agree that persons infected with toxoplasmosis have an increased risk for suicidal behavior (Arling *et al.*, 2009; Okusaga *et al.*, 2011; Zhang *et al.*, 2012; Pedersen *et al.*, 2012).

According to the study by Notarangelo *et al.* (2014) at the initial stage of toxoplasmosis, symptoms are either none or very limited. The chronic stage of infection is associated with forming intracellular cysts in neurons and glial cells. Chronic toxoplasmosis induced more neuro inflammation and increased production of kynurenine metabolites within the brain.

The study by Gaskell *et al.* (2009) showed that *T. gondii* parasite has the ability to encode two genes that are responsible for tyrosine hydroxylase, the enzyme responsible for producing L-dopa. This implies that changes in impulsivity as well as the regulation of fear could increase the risk for suicidal behavior accompanied by inflammatory changes in the CNS.

In a recent study by Cook *et al.* (2015), toxoplasmosis has been associated with intermediate phenotypes of suicidal behavior including trait aggression (in women) and impulsivity (in younger men) irrespective to mental illness.

Epidemiological studies on toxoplasmosis have indicated that congenital toxoplasmosis has impacts on

5000 newborns yearly in the United States (Jones *et al.*, 2007), leading to several conditions including prematurity, mental retardation and ocular disease (McLeod *et al.*, 2012). According to study by Jones *et al.* (2007), the prevalence of chronic toxoplasmosis among the US population was about 23%. It is worth to mention that although no direct physical risks are directed by the latent infection, chronic toxoplasmosis has been reported to have significant associations with elevated proportions of disturbing behaviors such as homicide, suicide and other self-directed violence and schizophrenia (Lester, 2012; Pedersen *et al.*, 2012; Fabiani *et al.*, 2013).

Toxoplasmosis and violence: Cook *et al.* (2015) conducted a study to investigate the possible association of latent toxoplasmosis with suicidal behaviors. The researchers analyzed traits of aggression and impulsivity for their relationship with IgG antibody seropositivity for *T. gondii*. Study sample included 1000 participants. Behavioral modes of suicide were measured using self-reported ratings of trait aggression scores and trait impulsivity. Study findings showed that IgG positivity of *T. gondii* was significantly associated with higher trait reactive aggression scores among women ($p < 0.01$). The positivity of *T. gondii* was also significantly associated with higher impulsive sensation-seeking among younger men ($p < 0.01$) aged 20-59 years old (median age = 60).

Zhang *et al.* (2012) conducted a study to associate *T. gondii* seropositivity and serointensity with scores of the self-rated Suicide Assessment Scale (SUAS-S) and to reassess previous positive association between *T. gondii* serointensity and a history of non-fatal suicidal self-directed violence. The study sample included 54 adult suicide attempters from Sweden in addition to 30 adult control subjects. Methods included assessment of participants for self-directed violence based on the SUAS-S. Study findings showed that there was a significant association between seropositivity of *T. gondii* (adjusted Odds Ratio (OR) = 7.12; 95% CI, 1.66-30.6; $p = 0.008$) and serointensity of *T. gondii* (adjusted OR = 2.01; 95% CI, 1.09-3.71; $p = 0.03$) with a history of non-fatal suicidal self-directed violence. Furthermore, seropositivity of *T. gondii* was found to be significantly associated with higher SUAS-S scores, a relationship significant for the whole sample ($p = 0.026$) but not for suicide attempters only.

Pedersen *et al.* (2012) conducted a study to examine whether *T. gondii* infected mothers have an increased risk of self-directed violence, violent suicide attempts and suicide and whether the risk depends on the level of *T. gondii* IgG antibodies. Study design was prospective cohort study and involved following up women from delivery in the range of 1992-1995 until 2006 in Denmark. Study sample included 45788 women whose level of

toxoplasma-specific IgG antibodies was measured in connection with child birth between 1992 and 1995. The main measures included incidence rates of self-directed violence, violent suicide attempts and suicide in relation to *T. gondii* seropositivity and serointensity. Study findings showed that there was a relative risk of self-directed violence of 1.53 (95% CI, 1.27-1.85) among mothers infected with *T. gondii* compared with non-infected mothers. It is worth to mention that the risk increased with increasing IgG antibody level. The results also revealed that in case of violent suicide attempts, the relative risk was 1.81 (95% CI, 1.13-2.84) and for suicide, 2.05 (95% CI, 0.78-5.20). CI, 0.98-2. Taken together, among women infected with toxoplasmosis, there is an increased risk of self-directed violence.

Study objectives: The objective of the present study is to determine the prevalence of seropositivity of IgG and IgM of *T. gondii* among inmates who were held on a physical violence actions charges. The study also aims assess the associate between toxoplasmosis with predictors including demographic variables.

MATERIALS AND METHODS

Study design: A cross-sectional study was conducted among a sample of inmates in the Correctional and Rehabilitation Centers in Jordan.

Study setting: The current study was conducted in the Correctional Rehabilitation Centers CRC in Jordan. Currently there is fourteen CRC in Jordan distributed in 7 of Jordan's 12 governorates. There is only one center for female inmates and the remaining 13 are for males. Centers capacity varies between 200-1000 inmates. The current study included CRC from all 7 governorates. The study was conducted in male CRCs only.

Study sample: Sample of the current study consisted of inmates from the Correctional Rehabilitation Centers CRC in Jordan. The general project consisted of collecting data from a national level sample and for the purpose of the current study only results pertaining to inmates who were charged with physical violence actions will be reported. Only adults aged 18 years or older are placed in the CRC as inmates. A total of 302 participants with physical violence were included.

Recruitment, informed consent and data collection: The study was approved by the Institutional Review Board of the Jordan University of Science and Technology, approval was also obtained from Public Security Directorate. Recruitment was done through

providing simple description of the study to CRC staff which they distributed among all inmates. Interested inmates notified the staff of their wish to participate in the study who in turn brought them to where the data collection by the research team is taking place. Participants were provided with an explanation of the study purpose and objectives and the opportunity to ask any question or concern related to the study. Participants were asked to provide their written informed consent prior to completing study questionnaires. They were also informed that their participation is voluntary and they can withdraw from the study at any time if they wish. Additionally, they were informed that their participation is anonymous and no one except the researchers has access to the data and that all study material will be kept safe in a locked secure place in the main researcher offices. After providing their consent to participate they were asked to complete a questionnaire that included questions regarding their history of violent actions, if they were involved in fights during and demographical data. During data collection CRC staff were only present outside the room where data collection took place and they were not involved in data collection.

Questionnaire: Background information including age, marital status, type of offense, level of education and occupation were collected. Participants were also asked about being involved in physical fights during the last 12 months. Answers for this variable were to choose of the following: None, Once, 2-5 times, >5 times.

Assessment of toxoplasmosis: Blood samples were collected from participants to detect the presence of IgM and IgG against *T. gondii* using ELISA technique. The sample was drawn in a plain tube from the participants then left to site for few minutes in order to clot. Then, the sample was inserted into a centrifuge to obtain the serum which then placed in small well sealed containers. Serum samples were then saved in an ice box to be transferred to a research lab in order to be reserved in a deep freeze temperature until being analyzed. Using the ELISA technique, *T. gondii* antibodies were assayed in the laboratory. Standardized cutoff points for seropositives were:

- IgM: Negative in range of 0-0.9; Positive ≥ 1
- IgG: Negative in range of 0-2.9; Positive ≥ 3

Control group included 200 participants from normal population.

RESULTS

General characteristics of participants: As shown in Table 1, the study included 302 male participants. The

Table 1: General characteristics of participants (N = 302)

Variables	Mean $\pm$ SD
Age (M $\pm$ SD) years	28.53 $\pm$ 8.44
Gender (N, %)	
Male	302 (100%)
Female	0 (0.0%)
Nationality (N, %)	
Jordanian	265 (87.7%)
Non-Jordanian	37 (12.3%)
Place of incidence (N, %)	
Home	45 (14.9%)
Work	52 (17.2%)
Street	152 (50.3%)
Missing	53 (17.5%)
Correctional rehabilitation centers (N, %)	
Balqa'a	72 (23.8%)
Swaqah	4 (1.3%)
Jwaideh	16 (5.3%)
Ma'an	3 (1%)
Aqaba	7 (2.3%)
Qafqafa	88 (29.1%)
Um-Aluluu	12 (4%)
Mawaqar2	24 (7.9%)
Zarqa	76 (25.2%)
Sentence (N, %)	
Arrested	212 (70.2%)
Condemned	48 (15.9%)
Missing	42 (13.9%)
Marital status (N, %)	
Married	96 (31.8%)
Divorced	177 (58.8%)
Widow	2 (0.7%)
Separated	8 (2.6%)
Missing	1 (0.3%)
Having children (N, %)	
Yes	80 (26.5%)
No	215 (71.2%)
Missing	7 (2.3%)
Religion (N, %)	
Muslim	290 (96%)
Christian	4 (1.4%)
Missing	8 (2.6%)
Educational level (N, %)	
$\leq$ secondary	263 (87.1%)
>secondary	30 (9.9%)
Missing	9 (3%)
Yearly income (M $\pm$ SD) JD	3529.65 $\pm$ 3620.48
Working during incidence	
Yes	184 (60.9%)
No	104 (34.4%)
Missing	14 (4.6%)
Have a current job (N, %)	
Yes	54 (17.9%)
No	191 (63.2%)
Missing	57 (18.9%)

mean age of participants was 28.53 $\pm$ 8.44 years. About 88% of participants were Jordanians. About 50% of violent actions occurred in the street, whereas the incidence of these actions took place in approximate rates in home and work (14.9, 17.2%, respectively). Among CRCs in the present study were nine as listed in Table 2, most of participants who were charged with physical violence actions were located in Qafqafa (29.1%), Zarqa (25.2%) and Balqa'a (23.8%). The sentencing of participants was mainly to arrest (70.2%) or to condemned (15.9%). Regarding marital status, about 59% of

Table 2: Frequency and distribution of *T. gondii* IgG and IgM among study participants

Parameters	Frequency
IgG (test) (N, %)	
Positive	82 (27.2%)
Negative	220 (72.8%)
IgM (test) (N, %)	
Positive	10 (3.3%)
Negative	292 (96.7%)
IgG (control) (N, %)	
Positive	24 (12%)
Negative	176 (88%)
IgM (control) (N, %)	
Positive	18 (9%)
Negative	182 (91%)

Table 3: The levels of *T. gondii* IgG and IgM for test group and control group

Variables	Mean±SD
IgG (test)	2.49±2.61
IgG (control)	1.98±1.14
IgM (test)	0.32±0.31
IgM (control)	0.41±0.27

participants were divorced while about 32% were married. The majority of cases (71.2%) had no children. Most of participants (96%) were Muslims. About 87% of participants had low educational level (secondary school or less). The mean yearly income was 3529.65±3620.48 Jordanian Dinars. About 61% of participants had works during the period of performing physical violent actions. About 63% of participants had no current jobs.

Frequency and distribution of *T. gondii* IgG and IgM among study participants: As shown in Table 2, among test group, there were 82 cases out of 302 (27.2%) positive for IgG, whereas 10 cases (3.3%) were positive for IgM. Among control group, 12% of cases were positive for IgG and 9% for IgM.

The levels of *T. gondii* IgG and IgM for test group and control group: As shown in Table 3, the level of IgG among test group was 2.49±2.61 and this was higher than that of IgG among control group (1.98±1.14). The level of IgM among control group was 0.41±0.27 and this was higher than that of IgM for test group (0.32±0.31).

The relationship of *T. gondii* IgG and IgM for test group and control group: As shown in Table 4, there were significant differences in the levels of *T. gondii* IgG between study and control groups ($p = 0.003$). There were also significant differences in the level of IgM between control and study groups ($p = 0.000$).

The relationship between each of *T. gondii* IgG, IgM and study variables: In this study, we tried to examine

Table 4: The relationship of *T. gondii* IgG and IgM for test group and control group

Variables	Mean	SD	p-values
IgG (test)	2.65	2.85	0.003
IgG (control)	1.98	1.14	
IgM (test)	0.31	0.29	0.000
IgM (control)	0.41	0.27	

Table 5: The relationship between each of *T. gondii* IgG, IgM and study variables

Variables	IgG (p-values)	IgM (p-values)
Sentence	0.917	0.898
Nationality	0.565	0.998
Marital status	0.166	0.879
Having children	0.349	0.215
Religion	0.932	0.706
Educational level	0.558	0.822
Working during incidence	0.613	0.794
Having a current job	0.073	0.348

possible associations of *T. gondii* IgG, IgM and study variables listed in Table 5. These variables included sentence, nationality, marital status, having children, religion, educational level, working during incidence and having current job. In all cases, no significant association was observed for either *T. gondii* IgG or IgM (p -values for all cases were >0.05).

DISCUSSION

The present study was conducted to investigate the prevalence of *T. gondii* IgG and IgM among prisoners with physical violent actions and to examine possible associations of toxoplasmosis with some study variables.

The data of our results showed that the prevalence of *T. gondii* was 27.2% among prisoners with physical violent actions. This finding is higher than that reported in other studies. The prevalence of *T. gondii* IgG in Egypt was reported to be 24.3% (Tenter *et al.*, 2000). The prevalence *T. gondii* in our study is less than that reported in Turkey, 46.8% (Tenter *et al.*, 2000).

Our results have indicated to significant differences in the levels of *T. gondii* IgG between study and control groups ($p = 0.003$) which implies the existence of biological effects resulting from latent toxoplasmosis. We agree with several studies that showed direct effects of toxoplasmosis on the host brain. These studies showed that persons infected with toxoplasmosis have an increased risk for suicidal behavior (Arling *et al.*, 2009; Okusaga *et al.*, 2011; Zhang *et al.*, 2012; Pedersen *et al.*, 2012).

Other studies showed that persons with latent infection of toxoplasmosis had a tendency to experience a variety of long-term personality changes (Webster, 2001). Among these changes are lower intelligence,

super-ego strength and novelty-seeking (low novelty seeking indicates rigid, loyal, stoic, slow-tempered and frugal personalities), guilt-proneness (Flegr and Hrdy, 1994; Flegr *et al.*, 1996, 2003). Other previous studies help in explaining our findings in which a high prevalence of toxoplasmosis would have higher aggregate neuroticism (personality trait in the study of psychology characterized by anxiety, moodiness, worry, envy and jealousy). Aspects of human culture associated with neuroticism are male control, materialism, rules and structure (Hofstede and McCrae, 2004).

CONCLUSION

The results of the present study confirmed other previous studies in which latent toxoplasmosis is significantly associated with violent behaviors. Our findings showed a significant difference in *T. gondii* IgG level among study group and control group. The same trend was observed for *T. gondii* IgM.

ACKNOWLEDGEMENT

This study was funded by the Jordan Scientific Research Support Fund (SRF)-Ministry of Higher Education, Jordan study #: 240/2010.

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