

Social Impacts of Infectious Diseases: Latent Toxoplasmosis and Crime

¹Ali Shotar, ²Sukaina A. Alzyoud and ¹Ahed J. AlKhatib

¹Department of Legal Medicine, Toxicology of Forensic Science and Toxicology,
School of Medicine, Jordan University of Science and Technology (JUST),
P.O. Box 3030, Irbid, Jordan

²Department of Community and Mental Health Nursing,
Faculty of Nursing, The Hashemite University, Zarqa, Jordan

Abstract: Infectious diseases have social impacts that are reflected through impacts on personality. Latent toxoplasmosis is an example of an association between personality disorders and infectious diseases. The aims of the present study are to determine the prevalence of seropositivity of IgG and IgM of *T. gondii* among inmates who were held on murder actions and to assess the association between toxoplasmosis with predictors including demographic variables. The methodology involved conducting a cross sectional study to collect data from 197 participants who were arrested for murder actions. A total of 200 participants from normal population were included as a control group. Study procedure involved constructing a questionnaire which included demographic variables and general information about participants that related to crime. It is also involved to withdraw a blood sample of each participant to assay the levels of *T. gondii* IgG and IgM using ELISA. Study findings showed that the prevalence of *T. gondii* was about 21% and that of IgM about 4%. A significantly association in the level *T. gondii* IgG between study and control groups was observed ($p = 0.010$) and another significantly association between study and control groups was also observed for *T. gondii* IgM ($p = 0.012$). Taken together, the present study showed a social impact of infection by latent toxoplasmosis on violent behaviors.

Key words: Infectious diseases, social impacts, personality, latent toxoplasmosis, *T. gondii* IgG, *T. gondii* IgM

INTRODUCTION

Health has been defined as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (Siteti and Injete, 2015).

Tuncay *et al.* (2015) conducted a study to explore a possible significant relationship between latent toxoplasmosis and clinical aspects of schizophrenia. They examined the seropositivity of *T. gondii* IgG among a sample of 94 patients with schizophrenia. Study findings showed that 46% of schizophrenic patients were positive for latent toxoplasmosis.

Toxoplasma gondii is an intracellular parasite that has the ability to induce infection among several hosts including humans who can be infected through the exposure to soil, water, undercooked meat and cat feces (Jones *et al.*, 2001). According to a study by Vyas *et al.* (2007), tissue cysts can induce and continuous alterations to neural tissues in rodents. Other studies that focused on human pointed to the possibility of *T. gondii* to exist in human central nervous system (Carruthers and Suzuki 2007; Torrey *et al.*, 2007). In their study, Yolken *et al.*

(2009) showed that the existence of latent forms of *T. gondii* in central nervous system have impacts on alterations of human mood and behavior (Yolken *et al.*, 2009).

Latent toxoplasmosis and culture: Lafferty conducted a study to show the impacts of latent toxoplasmosis on culture. Accordingly, the latent toxoplasmosis illustrates in part the change in aggregate neuroticism among populations and the ‘neurotic’ cultural dimensions of sex roles and uncertainty avoidance. According to researcher, there is a link that is proposed to combine culture and *T. gondii* resulting from a behavioral manipulation in which *T. gondii* employs to increase its transmission to its host, the cat. Furthermore, although latent toxoplasmosis is benign, the impact of parasite on individual personality seems to change the aggregate personality at the population level. It has also been mentioned that factors that affect the geographical changes relating to prevalence of *T. gondii* include the impacts of climate on the existence of infectious stages in soil, food preparation cultural aspects as well as retaining cats as pets.

Humans infected with latent toxoplasmosis seem to be subject to changes in personality (Webster, 2001). As an example, women infected with latent toxoplasmosis exhibited some changes in intelligence, superego strength and affectothymia while infected men seem to have lower intelligence, superego strength and novelty-seeking which reflects rigid, loyal, stoic, slow-tempered and frugal personalities). Furthermore, men and women infected with latent toxoplasmosis exhibit higher levels of guilt-proneness (Flegr and Hrdy, 1994; Flegr *et al.*, 1996, 2000, 2003).

Flegr (2013) conducted a study about latent toxoplasmosis and how it interferes with human. According to this study, a latent toxoplasmosis has not been considered harmful. Accumulative studies have indicated that global prevalence of toxoplasmosis (about 30%) may attribute to hundreds of thousands of deaths because of its impacts on the rate of traffic and workplace accidents as well as suicides. Additionally, latent toxoplasmosis is considered as a significant risk factor for schizophrenia. Proposed mechanisms implied mediation of these effects through increasing the secretion of dopamine and lowering the production of tryptophan which are products of manipulation activity by *Toxoplasma* to increase the possibility of transmission from intermediate to definitive host.

In his study, Lester (2012) showed that the prevalence of latent toxoplasmosis is associated with incidence of homicides which implies the involvement of toxoplasmosis in the extreme deviation of social behavior. Other studies have pointed to the ability of *Toxoplasma* to extend the reaction times of infected rodents and to modulate various stimulants including spontaneous activity, observance and recognition of novel stimuli (Vyas and Sapolsky, 2010; Webster and McConkey, 2010).

In Jordan, the relationship between latent toxoplasmosis and various aggressive models including crime has not been studied before up to the best knowledge of researchers.

Study objectives: The main objective of the present study was to determine the prevalence of seropositivity of IgG and IgM of *T. gondii* among inmates who were held on murder actions. The study also aims to assess the association between toxoplasmosis with predictors including demographic variables.

MATERIALS AND METHODS

Study design: This was a cross-sectional study to collect data from a selected 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.

Study sample: Study sample included 197 males with murder crimes.

Study procedure: Study procedure involved several steps including approval which was obtained from the Institutional Review Board of the Jordan University of Science and Technology and Public Security Directorate. Participants were recruited through providing simple description of the study to CRC staff which they distributed among all inmates. Inmates who were interested to participate informed the staff about their interest and the staff, in turn, brought them to the place of data collection. Participants received a summary about the study in terms of objectives, procedures and their voluntary participation and they have the right to withdraw from the study without being exposed to any adverse reaction. Participants were asked to provide a written consent form prior to starting the study. Furthermore, participants were informed that their participation is anonymous and their data will not be accessed except by research team. After that, participants were asked to fill the questionnaire which included questions regarding demographic data and general information about 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. A blood sample was collected from each participant to assess toxoplasmosis.

Assessment of toxoplasmosis: Blood samples were assayed for the existence of IgM and IgG against *T. gondii* using ELISA technique. Standardized cutoff points for sero positivity were:

IgM: Negative in range of 0-0.9.

Positive >0.9

IgG: Negative in range of 0-2.9.

Positive >2.9.

Control group included 200 participants from normal population.

RESULTS

Table 1 shows the general characteristics of participants, the mean age of participants was 31.45±10.45 years. About 86% of murders were Jordanians, the remaining proportion of murders belonged

Table 1: General characteristics of participants

Variables	Values
Age (M±SD) years	31.45±10.45
Gender (N, %)	
Male	197 (100%)
Female	0 (0.0%)
Nationality (N, %)	
Jordanian	169 (85.80%)
Saudi	4 (2.03%)
Kuwaiti	6 (3.05%)
Palestinian	4 (2.03%)
Lebanese	3 (1.52%)
Syrian	3 (1.52)
Egyptian	4 (2.03%)
Iraqi	1 (0.5%)
Missing	3 (1.52%)
Place of incidence (N, %)	
Home	60 (30.46%)
Work	15 (7.61%)
Street	97 (49.24%)
Missing	25 (12.70)
Sentence (N, %)	
Arrested	97 (49.24%)
Condemned	92 (46.70%)
Missing	8 (4.06%)
Marital status (N, %)	
Married	72 (36.56%)
Single	114 (57.87%)
Divorced	5 (2.54%)
Widow	2 (1.01%)
Separated	1 (0.5)
Missing	3 (1.52)
Having children (N, %)	
Yes	65 (32.99%)
No	130 (66%)
Missing	2 (1.01)
Educational level (N, %)	
≤Secondary	158 (80.20%)
>Secondary	35 (17.77%)
Missing	4 (2.03)
Working during incidence	
Yes	122 (61.93%)
No	64 (32.49%)
Missing	11 (5.58%)

to other Arabian countries including Kuwait (3.05%), Saudi Arabia, Palestine and Egypt shared the same proportions (2.03%). Place of incidence was the street in (49.24%) of cases followed by home (30.46%) and work (7.61%). About 49% of murders were arrested and about 47% were condemned. Out of 197 participants, 72 (36.56%) were married and 114 (57.87%) were single. About one third of participants (32.99%) had children and about two thirds (66%) had no children. Regarding the educational level, the sample of murders was not educated since, the educational level of about 80% was secondary school or less. About 62% of participants had work during incidence.

Frequency and distribution of *T. gondii* IgG and IgM among study participants: As shown in Table 2, the prevalence of IgG sero positivity was 20.81% and of IgM was 4.06%. Normal population (control group) had 12% sero positivity of IgG and 9% of IgM.

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

Variables	Values
IgG (test) (N, %)	
Positive	41 (20.81%)
Negative	156 (79.19%)
IgM (test) (N, %)	
Positive	8 (4.06%)
Negative	189 (95.94%)
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 (independent t-test)

Variables	Sum of squares	df	Mean square	F-values	p-values
IgG-test	2677.508	176	15.213	2.48	0.010
IgG-control					
IgM-test	24.970	45	0.165	1.80	0.012
IgM-control					

Table 4: The relationship between each of *T. gondii* IgG, IgM and study variables

Variables	IgG (p-values)	IgM (p-values)
Sentence	0.995	0.518
Nationality	0.798	0.979
Marital status	0.277	0.282
Having children	0.619	0.202
Place of incidence	0.360	0.395
Educational level	0.768	0.719
Working during incidence	0.681	0.343
Age	0.539	0.848

Table 5: Factors affecting the level of IgG using one way ANOVA test

Variables	Sum of squares	df	Mean of squares	F-values	p-values
Sentence-between groups	41.63	151	0.276	1.827	0.017
IgM-between groups	28.67	158	0.180	15.680	0.000

The levels of *T. gondii* IgG and IgM for test group and control group: As shown in Table 3, the levels of *T. gondii* IgG was associated significantly between study groups (p = 0.010). *T. gondii* IgM was also significantly associated between study groups (p = 0.012).

The relationship between each of *T. gondii* IgG, IgM and study variables: We investigated if there are significant relationships between study variables and each of *T. gondii* IgG and IgM. As shown in Table 4, no significant relationships were observed between all variables (p>0.05 for all).

Factors affecting the level of *T. gondii* IgG and IgM using one way ANOVA test: Using one way ANOVA test, two variables of significant association with *T. gondii* were observed, sentence between groups (p = 0.017) and IgM (p = 0.000) (Table 5).

Table 6: Factors affecting the level of IgM using one way ANOVA test

Variables	Sum of squares	df	Mean of squares	F-values	p-values
Place of incidence	118.67	119	0.997	1.71	0.016
Nationality	58.91	129	0.460	1.46	0.043
Having children	32.07	128	0.250	1.47	0.043

The level of IgM was significantly associated with three variables: place of incidence ($p = 0.016$), nationality ($p = 0.043$) and having children ($p = 0.043$) (Table 6).

DISCUSSION

The present study was conducted in view of the fact that latent toxoplasmosis interferes with personality and modulates human behaviors (Vyas and Sapolsky, 2010; Webster and McConkey, 2010).

The data of the present study showed that about 86% of participants were Jordanians and about 14% were from other Arabian countries which reflected the fact that Jordan has been affected by conditions that affect surrounding countries. It was interesting to find that street as the more likely place for the occurrence of violent actions (49.24%) followed by home (30.46%). We think that this may reflect the effect of latent toxoplasmosis. In this regard, we agree with the findings by Flegr (2013) who reported that the impact of latent toxoplasmosis is reflected on increased numbers of deaths. About two thirds of participants were single and about 80% of them had poor education. These two variables have their impacts on personality so that in addition to the possibility of being infected with latent toxoplasmosis, their reactions will not be well controlled. These findings agree with opinions expressed by Lafferty in which latent toxoplasmosis is among other factors that impact behaviors and culture.

Our results showed that the prevalence of *T. gondii* IgG was about 21%. This prevalence is less than that reported by other studies as an example, the prevalence of latent toxoplasmosis in Egypt was reported to be 24.3% (Tenter *et al.*, 2000). Also, findings from Turkey indicated to a prevalence of *T. gondii* about 47% (Tenter *et al.*, 2000). The prevalence of IgM was about 4% and we think of the possibility of recent infection while they were arrested.

The results of this study showed a significant association of the level of *T. gondii* IgG between study and control groups ($p = 0.010$). We agree with other studies in which the level of IgG against *T. gondii* was associated with deviant behaviors (Vyas and Sapolsky, 2010; Webster and McConkey, 2010).

Our results indicated the lack of association between each of *T. gondii* IgG and IgM with study variables which can be explained by having the impact of biological exposure to have the impact of deviating social behaviors.

CONCLUSION

The present study showed a social impact of infection by latent toxoplasmosis on violent behaviors.

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