

***Toxoplasma gondii* may be an advisor for aggressiveness: Seroprevalence of toxoplasmosis in murderer women in Iraq**

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Abstract

Background: Several studies have demonstrated the infection with *Toxoplasma gondii* can alter behavior and neurotransmitter function. In humans, acute infection with *T. gondii* can produce psychotic symptoms similar to those displayed by persons with schizophrenia. **Methods:** Fifty-four subjects (Women prisoners) with age range 20–55 years, 89 women not have crime record (as control group), with age range 15–60 years. Immunofluorescent assay was used to determine qualitative and quantitative IgG tested by automated VIDAS family instruments, this assay principle combines an enzyme immunoassay method by immunocapture with final fluorescent detection (ELFA). **Results:** The present study show significant differences between case control group and murder women group. Also, murder women had increased levels of serum IgG antibodies to *T. gondii* especially in high level IgG as compared with controls (1%), the significant value also revealed in all age groups al level 0.05 compare with control. **Conclusions:** This study suggested the a hypothesis that *T. gondii* is a risk factor for increasing aggressiveness in women, also, may be consider a main causative agent for murder behavior in women.

Keywords

Toxoplasma gondii, Seroprevalence, Murderer Women, Iraq

1. Introduction

Toxoplasma gondii is an intracellular parasite in the phylum Apicomplexa. Its life cycle can be completed only in cats and other felids, which are the definitive hosts. However, *T. gondii* also infects a wide variety of intermediate hosts, including humans. In many mammals, *T. gondii* is known to be an important cause of abortions and still births and to selectively infect muscle and brain tissue. A variety of neurologic symptoms, including incoordination, tremors, head-shaking, and seizures, have been described in sheep, pigs, cattle, rabbits, and monkeys infected with *T. gondii* (Torrey & Yolken, 2003). The principal mean of acquiring the infection is either by ingestion of inadequately cooked meat, primarily beef, pork, and lamb, or by contact with feral or domestic cats (Bogitsh *et al.*, 2013). Flegr (2007) found specific risk factors for *Toxoplasma* infection, such as contact

with cats and the eating of raw or undercooked meat.

T. gondii the cause of toxoplasmosis; when primary infection occurs during pregnancy the offspring has a markedly increased risk of CNS congenital abnormalities, including microcephaly, hydrocephalus, mental retardation, convulsions, cerebral calcifications, and chorioretinitis. Detection of Toxoplasma includes direct detection of the parasite, immunoassays for serum immunoglobulin (IgM & IgG) antibody, and elevation of maternal IgG antibody to Toxoplasma (Fawzy & Saber, 2009).

More recently, it has been found that the parasite has the ability to modify host behavior. Infected rats were shown to be less fearful of cats (the definitive host of the parasite) as compared to non-infected controls (Kamerkar & Davis, 2012).

In animals, infection with *Toxoplasma gondii* can alter behavior and neurotransmitter function. In humans, acute infection with *T. gondii* can produce psychotic symptoms similar to those displayed by persons with schizophrenia (Torrey & Robert, 2003).

In humans there are many studies demonstrated that *T. gondii* infection related with higher risk of traffic accidents, work accidents. *Toxoplasma*-infected men scored lower in clothes tidiness than uninfected men. Similarly, infected men scored lower and infected women scored higher in sociability. Also, the infected rural male students scored higher in suspiciousness while infected rural female students scored lower in suspiciousness as compared with control. (Flegr, 2013).

Ling *et al.* (2011) have been reported significantly *T. gondii* seropositivity and Suicide rates in Women. Furthermore, Seropositivity with *Toxoplasma* has been linked to neuropsychiatric disorders (schizophrenia, Parkinson and epilepsy disease), differences in several personality features between individuals in both infected men and women, car accidents, changes in personality, and more recently, suicidal attempts(Torrey *et al.*,2006; Leng *et al.*, 2011; Hurley *et al.*, 2012; Gatkowska *et al.*, 2012).

The mechanism of action by which *T. gondii* alters rodent behavior is unknown (Webster, 2006). Many factors are believed to play a role in mental health disorders, genetic, environmental, exposure to infectious agents, and chemical imbalances.

2. Materials and Methods

2.1. Immuno-Fluorescent Assay

The detection of anti-toxoplasma IgG in serum by using enzyme linked fluorescent assay (ELFA). In a present study the qualitative and quantitative IgM and IgG tested by automated VIDAS family instruments, this assay principle combines an enzyme immunoassay method by immune capture with final fluorescent detection (ELFA). The procedure of this assay accomplished by manufacture commercial kit by Biomerieux Company (France).

Subjects: Fifty-four subjects (Women prisoners) with age range 20–55 years. Blood samples were obtained from the subjects and control groups in the morning.

Control group: Consisted of 89 healthy volunteers. They were evaluated to rule out any medical and psychiatric disorders.

2.2. Statistical Analysis

All statistical analyses were performed using SPSS 10.0 statistical software (SPSS Inc., Chicago, USA). Descriptive statistics were shown in either mean \pm standard deviation notation or as frequency tables. Relations between the categorical variables were investigated by chi-square test. P-values less than or equal to 0.05 were considered statistically significant. Differences were considered significant with $p<0.05$.

2.3. Serum Collection

Five mL of blood was obtained from each prison's women and healthy subject by venipuncture, under sterile conditions. Serum was separated from whole blood by centrifugation at 1000 r.p.m. and was stored at -20°C until use. Lyses cells were centrifuged at 12000g f or one hour at 4°C.

2.4. Ethics

The all women were told about the importance and details of research and fully explain aims of this study. The protocol of ethics approved by ethical guide. Interestingly, some of them were refused to give the serum samples (Al-Hassnawi *et al.*, 2014).

3. Results

Table (1). Seroprevalence of *T. gondii* infection in murder and control women by using Enzyme

Prisons women IFA serum cut-off 8≤4 IU/ ml	Control IFA serum cut-off 8≤4 IU/ ml	Sig.
Positive	16	6
Negative	37	82
Equivocal	1	1
Total	54	89

* The mean difference is significant at the 0.05 level.

Table (2). Comparative IgG levels in toxoplasma positive women (control& murder) by using Enzyme immune-fluorescent assay.

IgG level	Prisons women		Control		Sig.
	No.	%	No.	%	
≥ 8 IU/ ml	1	2	1	1	0.20
8≤60IU/ml	8	15	4	4	0.48
60≤150IU/ml	4	7	1	1	0.22
≥ 300 IU/ ml	4	7	1	1	0.00

* The mean difference is significant at the 0.05 level.

Table (3). Seroprevalence of *T. gondii* infection in different age of groups in murder women and controls.

Age groups	No. of murder s women	Percentage of infection	Control	Percentage of infection	Sig.
20-26	14	5(36%)	48	4(8%)	0.00
27-32	15	3(20%)	24	1(4%)	0.00
33-38	12	4(33%)	6	0(0%)	0.00
39-44	8	2(25%)	7	1(14%)	0.078
≥45	5	2(40%)	4	0(0%)	0.00
Total	54	16	89	6(7%)	0.00

* The mean difference is significant at the 0.05 level.

The present study showed the percentage of infection in *Toxoplasma gondii* 30% (out of 54 Women prisoners cases 16 were antibody positives study) as compare with control case 7% (out of 89 healthy women only 6. The difference was statistically meaningful (Table 1). Murder women had increased levels of serum IgG antibodies to *T. gondii* especially in level ≥ 300 (7%), compared with controls (1%), where the difference in the seroprevalences was significant

(Table 2). Seroprevalence of *T. gondii* infection in different age of groups in murder women had a significant difference as compare with control at level 0.05 (Table 3). Our result also showed that the age groups more than 45 have high percentage of infection compare with control.

4. Discussion

To our knowledge, this is the first report of an association between elevated serum IgG antibody to Toxoplasma and the risk of murder behavior in women. Epidemiological studies world-wide, they detect infection of *T. gondii* by different mechanisms: agglutination; ELISA; IHA IFA test and real-time PCR (a direct diagnostic method) detects the presence of parasite DNA in the tissues of infected animals (Glor *et al.*, 2013). Each of these methods has different sensitivity and specificity. Thus one problem of several percentages of infection data in many country of the world may because the different sensitivity and specificity that leads to false positive and negative result. Also, the different persons have can develop anti-toxoplasma antibody according to age, sex, immune system response in acute or chronic infection, thus the titer of antibody is very important to diagnosis infection ,that's mean the sensitivity of technique most be acquired. Our result showed the significant differences in percentage of infection murder women as compare with control. As is well known, the most important and main reasons for the behavior of the killing of women is mental illness or schizophrenia. There are many studies indicated the relationship of toxoplasmosis, schizophrenic personality and other behavioral changes. We believe that there is a relationship between toxoplasma infection and murder behavior in women.

The mechanism of how chronic toxoplasmosis causes changes in neurotransmitter concentration is not well understood. One of behavioural manipulation hypothesis that assumed parasites can change the behaviour of hosts to increase the reproductive fitness of the parasite (vyas & Sapoalsky, 2010). It is clear that *T. gondii* causes an immune response in a subpopulation of people that is handled by incorrect immune cell types if the immune response is handled inappropriately then a cascade of events may follow resulting in neurotransmitter imbalances (Goodwin, 2011).

Henriquez *et al.* (2009) has reported the direct and indirect mechanisms whereby *T. gondii* might interfere with neural function. In mice, *T. gondii* has been demonstrated to infect neurons this infection could directly affect neuronal function and also can cause to neuron death. *T. gondii* genome is known to contain 2 aromatic amino acid hydroxylases, which potentially could directly affect dopamine and/or serotonin biosynthesis. The production of these enzymes potentially permitted the parasite to synthesize neurotransmitter precursors (Henriquez *et al.*, 2009; Goodwin, 2011). Immunological mediators such as interleukins and cytokines in brain and per ferial (IL-1, IL-6&TNF) interact with the brain at HPA axis where this interleukins able to stimulate prostaglandin E2 or act directly on the hypothalamus. The

IL-1 interacts with a group of nuclei in anterior hypothalamus, causing fever, sleep and increase production of adrenocorticotropic hormone ACTH (Virella, 2007). Also, these cytokines have been previously implicated in triggering depression in humans (Arling *et al.*, 2009).

Acute stress stimulate per ferial intererlukin-6, IL-1, which stimulates pineal activity presumably through enhanced sympathetic stimulation chronic stress is associated with elevated corticosteroids that reduced the pineal MAO activity and increase the melatonin production, (Norris, 2007). This immunological and hormonal parameter that may be assist the parasite to complete the life cycle, On the other hand, this parameter may change the most characteristic feature for host, for example, the free-running and fast walking is main feature of rodents, the reduce of melatonin can cause the change the body movement. This enhances predator chance (cats) to reach to prey and hunt it, finally the parasite can complete life cycle.

Although stimulation of the HPA axis has been linked Infection with *T. gondii* initiates a strong TH1immune response in which interferon- γ (IFN- γ), interleukin-12 (IL-12) and CD8 T-cells predominate IFN- γ mediates cognitive effects as sickness behavior and has been associated with clinical depression as exemplified by interferon therapy treatment of cancer and the resultant depressive side effects (McConkey *et al.*, 2013).

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To behavioral changes including depression, interestingly, this immune mediator can stimulates or to inhibition of glucocorticoids have profound effects on the immune system including macrophages, dendritic cells and T cells. Glucocorticoids act as antidepressant and effect on tryptophan metabolism, a precursor of melatonin and serotonin hormones. These hormones act as neuromodulator and finally may be act as behavioral manipulating. The hormonal and immunological variation that resulted by reaction and response of reaction causes to enhance or to complete life cycle (Al-Hassnawi & Al-Quraishi, 2013).

5. Conclusion

The results of the present study revealed that there was strong significant of *T. gondii* infection in different age of groups in murderer women as compare with control. Murder women had increased levels of serum IgG antibodies to *T. gondii* especially in level ≥ 300 than control. This study suggested the a hypothesis that *T. gondii* is a one factors that can cause manipulating of host behavior, also, may be consider a main causative agent for aggressiveness, such as murder behavior in women.

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