



## Influence of Toxoplasmosis on Human Personality Among Pregnant Women in Al-Najaf Province

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### ABSTRACT

One third of population around the developed countries is infected with *Toxoplasma gondii*. In the past 20 years, researchers have shown that this disease has a large influence on various aspects of human life. This study aims to determine the influence of toxoplasmosis on human personality among pregnant women in Al-Najaf province. Total 340 respondents within the age range 20-45 years old were pregnant women who had been diagnosed for toxoplasmosis. They were taken from the Obstetrics and Gynecology units in three governmental hospitals in Al-Najaf. In addition, the highest proportion of cases was in the age group of 25-29 years (32.4%), however, in the control group, it was in the age range 35-39 years (27.6%). According to the number of abortion, most of the cases had two cases of abortion (38.2%). On the other hand, most of the control respondents had zero abortion (20.0%), and there was a statistically significant difference between groups ( $p=0.001$ ). It also shows that there was not a statistically significant difference between these two groups according to the ages ( $p=0.248$ ). For the steroid hormones titrations (cortisol and free testosterone hormones) there was a statistical significant difference between groups ( $p=0.001$ ). In addition, there was not a statistical significant difference between the cortisol hormone titrations in acute cases than in chronic cases ( $p=0.694$ ). However, there was a statistical significant difference between the free testosterone hormone titrations in acute cases than in chronic ( $P=0.001$ ). In conclusion, these hormones in the cases group are considered a significant risk factor; however, in the control are considered a protective factor.

**Keywords:** Toxoplasmosis, Pregnant women, Steroid hormones, Human personality

### INTRODUCTION

Toxoplasmosis is a parasitic protozoan whose influence on human is in different ways. One of them is its impact on behavior and personality. Many studies have reported phenotypic traits, and suggested that many parasites change the host's phenotype during the infection period to increase the opportunities of their transition to another host. There are several causes why this particular protozoan became a preferred pattern for evolutionary scientist and researchers [1].

Firstly, *Toxoplasma* is considered a widespread parasite among all countries, and some patterns of these diseases have substantial effects on human health. So, all forms of toxoplasmosis infection are serious socio-economic burden worldwide [2]. In addition, it is considered very important to remember that the study of the effect of toxoplasmosis on the behavior and attitude of animals has a tradition which has been conducted since long time. There were around 20 studies that started in the early 1980s in the lab of William McPhee Hutchison. In the 1990s, Joanne P. Webster and Manuel Berdoy have followed that work. After that, many researchers like Skallová et al., Webster, Webster and McConkey, succeeded to study in this field [3-5].

There are crucial models to study the hypothesis of manipulation as the parasite tropically moves from mediator to host by predation predator and one of them is toxoplasmosis. In contrast, the behavioral patterns of parasites which is transmitted sexually is more common whereas, the behavioral patterns caused by the parasite that is metabolized are comparatively easy to determine [6]. In addition to its influence on personality profile and behavior, *Toxoplasma* is

known to affect other phenotypic traits in humans. For example, infected university male students (age 19-22 years) have increased concentrations of testosterone [7,8] and, from photographs, their faces are rated as more masculine and dominant by females [9]. In contrast, infected female students have decreased levels of testosterone which corresponds to decreased levels of testosterone in infected male and female mice [10].

Many studies have been done in Iraq concerning the detection of toxoplasmosis. However, the psychological effect of toxoplasmosis on pregnant women has gained little attention. Determination of psychological effects of toxoplasmosis on pregnant women is a very crucial step to take the correct step in planning to prevent its effects. This study aims to determine the influence of toxoplasmosis on human personality among pregnant women in Al-Najaf province.

## METHODOLOGY

### Study Location

This Comparative study was conducted in Al-Najaf province which is one among the eighteen provinces in Iraq. Al-Najaf province consists of six districts, namely, Najaf, Hydaria, Munathera, Al-Abbasia, Kufa, and Al-Mishkhab. In 2006, Al-Najaf had a population of 1,042,900, which represent 3.7% of total population in Iraq [11]. The respondents in this study, were pregnant women who have been diagnosed with toxoplasmosis, were taken from the Obstetrics and Gynecology units in three Governmental hospitals in Al-Najaf (Al-Zahra Teaching Hospital, Al-Sadr Teaching Hospital, and Laboratory Health Center) [12].

### Study Design and Sample

The study population consists of 340 pregnant women with toxoplasmosis that fulfilled the study criteria. This number of participants was selected using simple random sampling method, then divided into two groups (case and control) groups. A case is defined as pregnant women who had been diagnosed with toxoplasmosis infection, however, the control is defined as pregnant women who had negative evidence to infect with toxoplasmosis. The case and control were taken from the Obstetrics and Gynecology units in three Governmental hospitals in Al-Najaf.

### Sample Size

The  $p$  in the calculation of the sample size is taken from the previous study [13], with confidence interval  $p=0.05$  and power of study 1.645.

### Inclusion and Exclusion Criteria

**Inclusion criteria:** Cases were the pregnant women who had been diagnosed with toxoplasmosis infection (IgG +ve or IgM +ve) in the reproductive age, came for an antenatal check-up at the hospitals in Al-Najaf province. On other hand, the control was pregnant women who have negative laboratory evidence of toxoplasmosis (IgG -ve or IgM -ve) in the reproductive age, came for an antenatal check-up at the hospitals in same place.

**Exclusion criteria:** The pregnant women who had bad obstetric history and pregnant women who are not from Al-Najaf.

### Data Collection

Data was collected from 340 eligible respondents, who had given their consent letter to participate in this study. Concentration of steroid hormones which included testosterone and cortisol was assessed.

### Data Analysis

Statistical Package for the Social Sciences (SPSS) version 21 was used to analyze the data. Descriptive statistics, the frequencies, percentages, mean and standard deviation. Independent-sample t-test was used to compare mean at significant level ( $p<0.05$ ) between groups, odds ratio and logistic regression models were used to assess the impact of variables that were significantly associated ( $p<0.05$ ) with both groups.

### Ethical Considerations

This study was approved by Al-Najaf Health Directorate, Center of Training and Development of Staffs (ref: No.16818), also written consent was taken from all participants.

## RESULTS

Total 340 participants were involved in this study, 100% was the overall response rate and the statistical analysis was done based on this number. Both of group's data were normally distributed.

**Table 1 Comparing of ages and number of abortion of participants (Experiment and Control)**

Subjects	Experiment (N=170)	Control (N=170)	*P-value
	n (%)	n (%)	
<b>Age range: 20-45 years</b>			
Mean ± SD	29.1 ± 6.0	29.9 ± 6.1	-
20-24	45 (26.5)	42 (24.7)	0.248
25-29	55 (32.4)	46 (27.1)	
30-34	32 (18.8)	30 (17.6)	
35-39	32 (18.8)	47 (27.6)	
39-44	5 (2.9)	5 (2.9)	
≤ 45	1 (0.6)	0	
<b>No. of abortions</b>			
Mean ± SD	2.2 ± 0.9	1.5 ± 1.1	-
0	1 (0.6)	34 (20.0)	0.001
1	40 (23.5)	58 (34.1)	
2	65 (38.2)	48 (28.2)	
3	51 (30.0)	20 (11.8)	
4	13 (7.6)	10 (5.9)	

\*T-test at significant 0.05; SD: Standard Deviation

As can be seen from Table 1, the age range of the participants was 20-45 years old. According to the case group, the mean of age and standard deviation was 29.1 ± 6.0 years. However, the mean of age and standard deviation for the control group was 29.9 ± 6.1 years. In addition, the highest proportion of participants was in the age group of 25-29 years (32.4%). However, majority of the control participants were in the age group 35-39 years (27.6%). According to the number of abortion, most of the cases group had two cases of abortion (38.2%). On the other hand, most of control participants had zero abortion (20.0%).

It also shows that there was not a statistically significant difference between these two groups according to the ages ( $t=-1.157$ ,  $df=338$  and  $p=0.248$ ). On the other hand, there was a statistically significant difference between these two groups according to the number of abortion ( $t=6.446$ ,  $df=338$  and  $p=0.001$ ).

**Table 2 Comparing immunological clinical status of respondent (Case and Control) between steroid hormones**

Immunological clinical patients	Cases (N=170)	Control (N=170)	P-value*
	Mean ± SD	Mean ± SD	
Cortisol hormone (Pg/mL)	14.937 ± 2.730	6.046 ± 2.958	(339) 0.001
Free testosterone hormone (Pg/mL)	30.426 ± 14.742	7.317 ± 6.738	(339) 0.001

\*T-test significant at 0.05; Pg/mL: Picograms per milliliter; SD: Standard Deviation

This Table 2 shows that there was a statistical significant difference between the cortisol hormone titrations in cases than in control group ( $t=28.797$ ,  $df=339$  and  $p=0.001$ ). It also shows that there was a statistical significant difference between the free testosterone hormone titrations in cases than in control group ( $t=18.950$ ,  $df=339$  and  $p=0.001$ ).

**Table 3 Comparing immunological clinical status of respondent (acute and chronic) for cortisol and free testosterone hormone**

Immunological clinical patients	Status	Cases	P-value*
		(N) Mean ± SD	
Cortisol hormone (Pg/mL)	Acute	(80) 15.024 ± 2.989	(168) 0.694
	Chronic	(90) 14.859 ± 2.492	
Free testosterone hormone (Pg/mL)	Acute	(79) 41.390 ± 14.271	(168) 0.001
	Chronic	(91) 20.908 ± 5.868	

\*T-test significant at 0.05; Pg/mL: Picograms per milliliter; SD: Standard Deviation

The results in the Table 3 reveals that there was not a statistical significant difference between the cortisol hormone titrations in acute cases than in chronic cases ( $t=0.394$ ,  $df=168$  and  $p=0.694$ ). However, there was a statistical significant difference between the free testosterone hormone titrations in acute cases than in chronic ( $t=12.530$ ,  $df=168$  and  $p=0.001$ ).

**Table 4 Crude odds ratios (95% confidence intervals) and logistic regression model of steroid hormones for both groups (case and control)**

Steroid hormones	Odds ratio (95% CI)	
	Case	Control
Cortisol hormone (Pg/mL)	1.34 (0.75 to 2.38)	0.66 (0.21 to 2.06)
Free testosterone hormone (Pg/mL)	14.48 (3.71 to 56.50)	0.43 (0.37 to 0.50)

Pg/mL: Picograms per milliliter

Table 4 indicates that the odds ratios for both steroid hormones (cortisol and free testosterone) in the case group was more than 1. However, the odds ratio for same hormones in the control group was less than 1.

### DISCUSSION

This study shows that the age range of the participants was ( $20 \leq 45$ ) years old. Mean of age and standard deviation of case group was  $29.1 \pm 6.0$  years. However, for the control group was  $29.9 \pm 6.1$  years. In addition, the highest proportion of cases was in the age group of 25-29 years (32.4%), however, in the control was in the age group 35-39 years (27.6%). According to the number of abortion, most of the cases group had two cases of abortion (38.2%). In other hand, most of control respondents had zero abortion (20.0%).

It also shows that there was not a statistically significant difference between these two groups according to the ages ( $t=-1.157$ ,  $df=338$  and  $p=0.248$ ). In other hand, there was a statistically significant difference between these two groups according to the number of abortion ( $t=6.446$ ,  $df=338$  and  $p=0.001$ ).

Flegr in 2007 in a study, that was carried out among students and faculty in the Department of Biology at Charles University in the Czech Republic, reported that in general, differences in personality factors were greater in subjects in older age groups [14]. This finding is compatible with our result but for control group, however, the situation in the cases is different most of them were in the age group 24-29 years. That means the result of this study is different, might be this difference related to variation between communities or related to the factors of personality between those peoples.

This study also reveals that there was a statistical significant difference between the cortisol hormone titrations in cases than in control group ( $t=28.797$ ,  $df=339$  and  $p=0.001$ ). It also shows that there was a statistical significant difference between the free testosterone hormone titrations in cases than in control group ( $t=18.950$ ,  $df=339$  and  $p=0.001$ ) (Table 2). This result agreed with the result of Shirbazou et al., 2017, they found that the increased concentration of testosterone was also recently reported in *Toxoplasma*-infected men, women [15]. In other hand, recent studies performed on two independent populations did not find increased levels of testosterone in infected male soldiers and immunology clinic patients [16]. Flegr, et al., have confirmed the result of our study, they found that *Toxoplasmosis* is influenced on personality profile and behavior, its known to affect other phenotypic traits in humans and increased concentrations of testosterone [7,8].

In addition, this study reveals that there was not a statistical significant difference between the cortisol hormone titrations in acute cases than in chronic cases ( $t=0.394$ ,  $df=168$  and  $p=0.694$ ). However, there was a statistical significant difference between the free testosterone hormone titrations in acute cases than in chronic towered acute cases ( $t=12.530$ ,  $df=168$  and  $p=0.001$ ) (Table 3). These results were confirmed by James results, he found that the increased sex ratio of recently infected women with toxoplasmosis and decreased sex ratio of women infected for a long time, higher estrogen and testosterone levels in *Toxoplasma* infection-sensitive subjects and a reduced concentration of these hormones as consequence of long-term infection has also been suggested [16,17]. The increased sex ratio of recently infected women can also be explained by Catalano's stress hypothesis [18].

Finally, the result of this study revealed that the odds ratios for both steroid hormones (cortisol and free testosterone) in the cases group was more than 1. However, the odds ratio for same hormones in the control group was less than 1. That means these hormones in the cases group are considered a significant risk factor, however, in the control are

considered a protective factor. This result is related to infect the pregnant women with toxoplasmosis and its effect on the personality and behavior of patients especially the pregnant women.

### CONCLUSION AND RECOMMENDATIONS

In conclusion, it can be stated that there was a statistical significant difference between the steroid hormones titrations (cortisol and free testosterone hormones) in cases than in the control group. In addition, there was not a statistical significant difference between the cortisol hormone titrations in acute cases than in chronic cases. However, there was a statistical significant difference between the free testosterone hormone titrations in acute cases than in chronic. Finally, these hormones in the cases group are considered a significant risk factor, however, in the control are considered a protective factor. These results contributed to correlate toxoplasmosis infected pregnant women and the effect of infection on the personality and behavior of pregnant women.

### DECLARATIONS

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