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Evaluation of Cortisol Hormone Levels among Miscarriage Women with Toxoplasmosis in Suleimani Province

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ABSTRACT

Introduction:
This study aimed to determine the seroprevalence of toxoplasmosis among women with a history of miscarriage in Sulaimani City, Iraq, and to assess its association with serum cortisol levels in relation to sociodemographic, clinical, and behavioral factors.

Materials and Methods:
A cross-sectional study was conducted on 119 women who experienced miscarriage. Sociodemographic information, clinical history, and behavioral data were collected using structured questionnaires. Serum samples were tested for anti-Toxoplasma IgG and IgM antibodies as well as cortisol levels through electrochemiluminescence immunoassay (Roche Cobas e 411). Statistical analysis included chi-square tests, Spearman correlation, and logistic regression to identify potential risk factors associated with Toxoplasma positivity.

Results:
Out of 119 women, 28 (23.5%) tested positive for Toxoplasma gondii antibodies. The highest prevalence was recorded in women aged 27–36 years (56.0%, p=0.001). Educational status showed a significant association, with women having only primary education exhibiting the highest seropositivity (50.0%, p=0.019). No significant differences were found between urban and rural participants (p=0.563). Regarding cortisol levels, most participants (74.8%) had values within the normal range, while 7.6% had low and 17.6% had elevated cortisol levels. However, cortisol status was not significantly associated with Toxoplasma seropositivity (p=0.765).

Conclusion:
The study demonstrates cortisol levels did not show a significant association with infection status, these findings emphasize the importance of targeted education, awareness, and screening programs. Further longitudinal studies are recommended to clarify causal pathways and better prevent pregnancy complications related to toxoplasmosis.

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Introduction

Toxoplasma gondii is a ubiquitous intracellular protozoan parasite that infects approximately one-third of the global population (1). While often asymptomatic in immunocompetent individuals, infection during pregnancy can result in severe consequences, including miscarriage, stillbirth, or congenital toxoplasmosis (2). In regions with limited access to routine screening, such as parts of the Middle East, the true burden of T. gondii on reproductive health may be underrecognized(3). Serological detection of T. gondii-specific antibodies remains the primary method for identifying both past and recent infections. This approach provides valuable information on an individual's exposure history and potential risk to the fetus during pregnancy, making it an essential tool in the diagnosis and management of toxoplasmosis (4). Stress has long been recognized as a potential co-factor in adverse pregnancy outcomes (5). Cortisol, the primary glucocorticoid hormone released in response to stress, plays a crucial role in modulating immune function. Elevated cortisol levels are associated with immune suppression, which could influence susceptibility to infections or alter immune responses to pathogens such as

T. gondii. However, the interaction between cortisol levels and toxoplasmosis serostatus remains poorly understood, especially in populations with a high rate of pregnancy loss (6).This study aimed to determine the seroprevalence of Toxoplasma gondii infection among women with a history of miscarriage in Sulaimani City, Iraq, and to assess its association with serum cortisol levels. Cortisol was investigated due to its immunomodulatory effects, which may influence susceptibility to toxoplasmosis and adverse pregnancy outcomes.

Materials and Methods

Study Design and Participants:

This cross-sectional study was conducted at the Maternal Teaching Hospital in Suleimani, Iraq. A total of 119 women with a history of miscarriage and within 1–15 weeks of gestation were enrolled. Women with chronic illnesses causing immunosuppression (e.g., uncontrolled diabetes, HIV, autoimmune disorders, or corticosteroid therapy) were excluded to avoid confounding effects on cortisol levels and immune response.

Sample Collection and Laboratory Analysis:

Venous blood samples (5 ml) were collected between 24 and 72 hours after abortion to capture the acute post-abortion stress response. Whenever possible, samples were drawn between 08:00 and 010:00 AM to minimize diurnal variation in cortisol levels. Serum was separated for measurement of cortisol and anti-Toxoplasma IgM and IgG antibodies using the Roche Cobas e 411 analyzer (electrochemiluminescence immunoassay). Both IgM and IgG antibodies were included to capture recent (IgM) as well as past or latent (IgG) exposure to T. gondii, as latent infection may still contribute to adverse pregnancy outcomes. Toxoplasma positivity was defined by the presence of IgM and/or IgG antibodies.

Data Collection:

Sociodemographic data (age, education, residence), clinical history (miscarriage number, chronic disease, infections), and behavioral risk factors (cat ownership, gardening, stress levels) were collected using a structured questionnaire.

Statistical Analysis:

Data were analyzed using SPSS. Chi-square and Fisher's exact tests were used to identify associations between categorical variables. Spearman correlation assessed relationships between continuous and ordinal variables.

Ordinal logistic regression was used to identify predictors of cortisol level categories. Statistical significance was set at $p < 0.05$.

Results

A total of 119 women who experienced miscarriage participated in this study. The analysis focused on the detection of Toxoplasma gondii infection through serological testing and the measurement of serum cortisol levels as a marker of physiological stress.

In addition, various sociodemographic characteristics were examined to explore potential associations with Toxoplasma infection. The results are presented in the following sections.

Toxoplasma Seroprevalence

Out of 119 women, 28 (23.5%) were seropositive for *T. gondii*, while 91 (76.5%) were seronegative, indicating that nearly one in four participants had been exposed to or infected with the parasite. Detailed antibody profiles showed that 27 women (22.7%) were IgG-positive, of whom 2 were also IgM-positive, while 1 woman (0.8%) was IgM-positive only (Table 1).

Table1: Distribution of Toxoplasma IgM and IgG Antibodies (n = 119)

Antibody	Category	Frequency (%)
IgM	Positive	3 (2.5)
	Negative	116 (97.5)
	Total	119 (100.0)
IgG	Positive	27 (22.7)
	Negative	92 (77.3)
	Total	119 (100.0)
Distribution of IgM and IgG antibodies among study participants, showing the number and percentage of women positive and negative for *Toxoplasma gondii* (n = 119).		

Serum Cortisol Levels

Serum cortisol levels were categorized into three ranges. The majority of participants (74.8%) had normal cortisol levels (170–534 nmol/L). Low cortisol levels (<170 nmol/L) were found in 9 participants (7.6%), whereas 21 participants (17.6%) exhibited elevated cortisol levels (>534 nmol/L) (Table 2).

Table2: Distribution of Toxoplasma Status and Serum Cortisol Levels

Variable	Category	Frequency (%)
Toxoplasma	Positive	28 (23.5)
	Negative	91 (76.5)
	Total	119 (100.0)
Serum Cortisol	<170 (Low)	9 (7.6)
	170–534 (Normal)	89 (74.8)
	>534 (High)	21 (17.6)
	Total	119 (100.0)
The table presents the distribution of *Toxoplasma gondii* infection status and serum cortisol levels among the study participants (n = 119).		

Sociodemographic Associations

There was a statistically significant association between age group and *Toxoplasma* seropositivity (χ^2 = 13.15, p = 0.001). The highest proportion of *Toxoplasma*-positive cases was found in the 27–36 years age group, accounting for 56.0% of all positive cases. In contrast, the 37–46 years group showed a higher proportion of *Toxoplasma*-negative individuals (46.4%). A significant association was also observed between education level and *Toxoplasma* status (χ^2 = 0.023, p = 0.019). Individuals with only primary education had the highest rate of *Toxoplasma* positivity (50.0%), while those with a university degree had the lowest (14.3%).No significant association was found between place of residence and *Toxoplasma* status (χ^2 = 0.455, p = 0.563). Both urban and rural residents had comparable rates of infection, suggesting that living environment alone may not be a determining factor in this sample (Table 2).

Table 3: Association Between Sociodemographic Characteristics and *Toxoplasma* Status

Sociodemographic Characteristics	Category	Toxoplasma Positive	Toxoplasma Negative	Total (Freq/%)	χ^2 / P-value
Age group	17 - 26	21 (23.1)	10 (35.7)	31 (26.1)	13.15 / 0.001*
	27 - 36	51 (56.0)	5 (17.9)	56 (47.1)	
	37 - 46	19 (20.9)	13 (46.4)	32 (26.9)	
Education Level	Primary	14 (50.0)	22 (24.2)	36 (30.3)	0.023 / 0.019*
	Secondary	5 (17.9)	20 (22.0)	25 (21.0)	
	High School	5 (17.9)	12 (13.2)	17 (14.3)	
	University Degree	4 (14.3)	37 (40.7)	41 (34.5)	
Residence	Urban	22 (78.6)	77 (84.6)	99 (83.2)	0.455 / 0.563
	Rural	6 (21.4)	14 (15.4)	20 (16.8)	
The table shows the number and percentage of women testing positive and negative for *T. gondii* by age group, education level, and residence, highlighting significant associations for age and education but not for residence.					

Association Between Serum Cortisol Levels and Toxoplasma Status

Among women with low cortisol levels (<170 nmol/L), 10.7% were *Toxoplasma*-positive and 6.6% were negative. In the normal cortisol group (170–534 nmol/L), the majority of both positive (71.4%) and negative (75.8%) cases were observed.

For high cortisol levels (>534 nmol/L), 17.9% of positive and 17.6% of negative cases were noted. Statistical analysis using the chi-square test revealed no significant association between cortisol level categories and *Toxoplasma* status (χ^2 = 0.537, p = 0.765) (Table3).

Table 4: Association Between Serum Cortisol Levels and Toxoplasma Status

Variable	Category	Toxoplasma Positive	Toxoplasma Negative	Total (Freq/%)	χ^2 / P-value
Serum Cortisol	<170 (Low)	3 (10.7)	6 (6.6)	9 (7.6)	0.537 / 0.765
	170–534 (Normal)	20 (71.4)	69 (75.8)	89 (74.8)	
	>534 (High)	5 (17.9)	16 (17.6)	21 (17.6)	
Total		28 (100.0)	91 (100.0)	119 (100.0)	
This table shows the number and percentage of participants who tested positive or negative for *Toxoplasma gondii* across different serum cortisol level categories.					

Discussion

This study investigated the relationship between *Toxoplasma gondii* infection, serum cortisol levels, and selected sociodemographic characteristics among women who experienced miscarriage.

The overall prevalence of *T. gondii* seropositivity was 23.5%, which is comparable to findings from Baghdad, where a prevalence of 21.7% was reported among women with a history of abortion (7). Similar prevalence levels have been observed across the WHO Eastern Mediterranean Region, where *T. gondii* infection remains common among pregnant and reproductive-aged women, with rates often ranging between (20- 40%) depending on geographical, cultural, and dietary factors (3). The relatively high prevalence observed in this study underscores the ongoing public health relevance of toxoplasmosis in the region, particularly as a potential cause of adverse pregnancy outcomes(8).

Regarding cortisol levels, the majority of participants (74.8%) had cortisol values within the normal reference range, while 17.6% exhibited elevated levels and 7.6% had low levels. Cortisol, as the primary glucocorticoid hormone, plays a pivotal role in stress adaptation and immune regulation.

Elevated cortisol levels are well documented to suppress immune function—attenuating pro-inflammatory signaling, reducing lymphocyte activation, and impairing antibody production (9). Furthermore, chronic stress can lead to glucocorticoid resistance, undermining

cortisol's regulatory effects and resulting in immune dysregulation (10). Nevertheless, In our study, we did not find a statistically significant relationship between cortisol levels and *Toxoplasma gondii* infection status (p = 0.765). This means that, within our sample, women who had higher or lower cortisol levels were not more likely to test positive or negative for *T. gondii*. Although stress — and therefore cortisol release — is common in women who experience miscarriage, our findings suggest that cortisol changes alone may not be a key factor in determining whether a woman has the infection. Other influences, such as differences in immune system function, nutritional status, environmental exposures, or the timing of infection, might play a stronger role in determining infection risk in this group. The analysis of sociodemographic variables revealed two significant associations with *T. gondii* infection. Firstly, age group was significantly related to *Toxoplasma* seropositivity (p = 0.001), with the 27–36 years cohort showing the highest infection rate. This finding aligns with a study conducted in Zakho City, Iraq, which reported a notable seroprevalence among females of childbearing age .This finding may be related to greater cumulative exposure risk during peak reproductive and working years (8). Secondly, education level was significantly associated with infection status (p = 0.019), where women with only primary education had higher seroprevalence than those with university degrees. This is consistent with findings from a study in Duhok province, Iraq, which indicated that lower educational attainment correlates with reduced knowledge about toxoplasmosis transmission and preventive measures (11). This aligns with previous studies indicating that lower educational attainment may be associated with limited awareness of toxoplasmosis transmission routes and preventive measures, such as safe food handling and avoidance of undercooked meat (12). Conversely, residence location (urban vs. rural) was not linked to infection rates. This is in line with a study from Al-Najaf province, Iraq, which found no significant difference in *T. gondii* seroprevalence between urban and rural areas (13). The lack of a significant association between cortisol levels and *Toxoplasma gondii* infection in this study should be interpreted cautiously. Cortisol levels fluctuate rapidly and can be influenced by various stressors unrelated to infection. Additionally, the cross-sectional design limits conclusions about temporal or causal relationships between cortisol changes and infection status. Future longitudinal studies including pro-inflammatory cytokines as biomarkers could better clarify the complex interactions between stress, immune response, and toxoplasmosis, especially in reproductive health. Overall, these findings highlight the need for targeted public health interventions focusing on education and preventive practices among women of reproductive age, particularly those with lower educational backgrounds. Early detection and management of toxoplasmosis in pregnancy remain critical to reducing its contribution to miscarriage and other adverse obstetric outcomes.

Conclusion

This study reveals a notable prevalence of Toxoplasma gondii infection among women who have experienced miscarriage, particularly in the 27–36 years age group and those with lower educational attainment. While serum cortisol levels varied among participants, no direct association with T. gondii serostatus was observed, suggesting that cortisol alone may not be a decisive factor in infection risk or miscarriage related to toxoplasmosis. However, the observed immuno-endocrine interplay and the significant sociodemographic correlations emphasize the complexity of factors influencing maternal infection and pregnancy outcomes. Given the limitations of the cross-sectional design, further longitudinal research incorporating immune markers and stress-related biomarkers is essential to elucidate causal pathways. In the meantime, enhanced public health efforts focusing on education, awareness, and early screening for toxoplasmosis in reproductive-aged women are urgently needed to mitigate its impact on maternal and fetal health in this region.

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