

Article

The Association Between *Toxoplasma gondii* Infection and Spontaneous Abortion in Women in Iraq: A Systematic Literature Review

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Abstract: The objective of this systematic literature review is to pool the available evidence to assess the association between *Toxoplasma gondii* (*T. gondii*) infection and the occurrence of spontaneous abortion among women in Iraq. A comprehensive search of the academic literature was performed for studies on the seroprevalence of *T. gondii* in women with spontaneous abortion from different regions of Iraq. Context was provided by including relevant international and regional studies. This review includes observational studies with a preferential selection of studies with clear diagnostic criteria and demographic data. Data on prevalence, risk variables and study characteristics were retrieved and synthesised narratively. The pooled evidence suggests a significant seroprevalence of *T. gondii* infection among women with spontaneous abortion in several Iraqi governorates such as Sulaimani, Baghdad, Erbil, Basra and Babylon. Some research from these regions confirmed the existence of *T. gondii* antibodies (IgG and IgM) and the statistically significant relationship between *T. gondii* antibodies and pregnancy loss. The stated prevalence rates in Iraqi research are comparable, and in some cases higher, than neighbouring countries in the WHO Eastern Mediterranean Region. Key risk factors found include eating undercooked meat and direct contact with cats. *Toxoplasma gondii* infection is an important yet unrecognised risk factor for spontaneous abortion in Iraq. The findings strongly support the need for systematic serological screening for toxoplasmosis as part of standard prenatal care regimens throughout the country. Public health initiatives that provide information on preventive measures to women of reproductive age are crucial to minimising the incidence of toxoplasmosis-associated pregnancy loss.

Keywords: *Toxoplasma gondii*, Toxoplasmosis, Spontaneous Abortion, Miscarriage, Iraq, Systematic Review, Public Health

Introduction

Toxoplasma gondii is an obligate intracellular protozoan parasite that is found worldwide and estimated to infect up to one-third of the world's population [1]. In immunocompetent adults infection is usually asymptomatic but initial infection acquired during pregnancy offers a serious threat to the developing foetus [2]. The parasite can penetrate the placental barrier resulting to congenital toxoplasmosis that can present as a triad of chorioretinitis, hydrocephalus and cerebral calcifications or can result in more severe outcomes such as foetal demise and spontaneous abortion

(miscarriage) [3]. Spontaneous abortion is the most common complication of early pregnancy. Its aetiology is multifaceted, including genetic abnormalities, endocrine disorders, anatomical problems and infectious agents. The infectious causes are the TORCH complex (Toxoplasmosis, Other agents, Rubella, Cytomegalovirus, Herpes simplex) which is the most important in clinical terms [4]. The patho-immunological effects of *T. gondii* and in particular the robust inflammatory responses it can evoke, are highly linked in placental malfunction and eventual pregnancy loss. The association of *T. gondii* infection (both acute and chronic) with an increased incidence of spontaneous abortion has been suggested by studies [4,5]. The incidence of toxoplasmosis and the reproductive difficulties associated with it differ considerably from one geographical area to another, depending on the local climate, dietary patterns, agricultural methods, and public health infrastructure. Higher prevalence of infection in the WHO Eastern Mediterranean Region encompassing Iraq can be due to ingestion of raw or undercooked meat, contact with soil or water contaminated with oocysts from cat faeces, and socio-political instability. Several studies have been conducted in various Iraqi towns like Sulaimani, Baghdad, Erbil and Basra to study the association of *T. gondii* with abortion. However, no complete synthesis of such localised data is available [1]. This systematic literature review attempts to address this knowledge gap by synthesising the available evidence from research conducted in Iraq. The main purpose is to estimate the seroprevalence of *T. gondii* among women with spontaneous abortion and to critically examine the strength of link between the infection and this unfavourable pregnancy outcome in the Iraqi setting [1,2]. This study aims to synthesise these findings to influence clinical practice, public health policy and future research objectives to reduce the impact of toxoplasmosis on reproductive health in Iraq.

Literature Review and Theoretical Framework

The Biology and Pathophysiology of *Toxoplasma gondii*

Toxoplasma gondii is characterised by a complex life cycle with felines as definitive hosts and numerous warm-blooded species, such as humans, as intermediate hosts. There are three main routes by which humans may become infected. Eating tissue cysts (bradyzoites) in rare meat. Eating food or drinking water containing oocysts transmitted in cat faeces. Vertical transmission of tachyzoites from an infected mother to her foetus. Once ingested, the parasite splits into invasive tachyzoites which disseminate throughout the body and can infect virtually every nucleated cell [6].

Immunological Response to *T. gondii* Infection During Pregnancy

A successful pregnancy depends on a fine immunological balance, a shift toward tolerance to avoid rejection of the baby. The balance is upset by infection with *T. gondii*. The first infection triggers a strong pro-inflammatory Th1 immune response with production of cytokines including interferon-gamma (IFN- γ) and tumour necrosis factor-alpha (TNF- α) [7]. This response is vital in controlling parasite growth but an over exuberant Th1 response at the maternal-fetal interface can be detrimental to placental integrity and foetal survival. However, an infection could negatively effect regulatory T cells (Tregs) which are required for immunological tolerance during pregnancy which could lead to adverse outcomes. This has been shown in mice models. In chronic infections the parasite remains as latent bradyzoites in tissue cysts but can reawaken during times of immunosuppression and constitute an ongoing hazard [8].

Proposed Mechanisms of *Toxoplasma gondii*-Induced Spontaneous Abortion

There are several pathways that explain how *T. gondii* might cause to spontaneous abortion. The most direct mechanism is transplacental transmission of tachyzoites, which can cause direct cellular damage in the placenta (placentitis) and foetal tissues, leading to serious congenital abnormalities or foetal mortality [9]. Furthermore, the released parasitic effectors proteins could influence the host cell activities and induce apoptosis, which may contribute to the tissue damage. Pregnancy loss can also be caused indirectly by the maternal inflammatory response. Excessive pro-inflammatory cytokines compromise placental vasculogenesis and nutrition delivery resulting to placental insufficiency and ultimately foetal mortality [8]. There are studies in Iran and all over the world that corroborate these biological assumptions, and in which the presence of *T. gondii* antibodies has always been associated to an increased risk of miscarriage.

Global and Regional Epidemiology of Toxoplasmosis in Women with Pregnancy Loss

A landmark systematic review and meta-analysis established that *T. gondii* infection is a significant worldwide risk factor for spontaneous abortion. The burden is especially significant in developing regions, where the risk factors are more common. Studies from the Middle East provide important background to the situation in Iraq [1,10]. A meta-analysis in Iranian women identified a significant link between toxoplasmosis and spontaneous abortion, and recommended further research to lower the burden of toxoplasmosis. Similarly, research from northwest Iran and a comprehensive assessment of the WHO Eastern Mediterranean Region have demonstrated that *T. gondii* is a significant contributor to unfavourable pregnancy outcomes including miscarriages and stillbirths [5]. These regional results point to the possibility of a similar, or worse, situation in Iraq, a country with numerous epidemiological similarities to its neighbours.

Materials and Methods

Review Protocol and Registration

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards were followed in performing this systematic review. The protocol was created a priori to determine the study questions, search technique and eligibility criteria.

Search Strategy and Information Sources

A systematic search of the literature was undertaken in electronic databases including PubMed/MEDLINE, Scopus and Google Scholar for the publications published till September 2025.

Eligibility Criteria: Inclusion and Exclusion of Studies

Studies were included if they fulfilled the following criteria: (1) original observational studies (cross-sectional, case-control or cohort); (2) explored the prevalence or correlation of *T. gondii* infection in women with spontaneous abortion; (3) were conducted in Iraq; and (4) used serological (ELISA for IgG/IgM) or molecular (PCR) methods for diagnosis. Exclusion criteria were: (1) studies focusing exclusively on animal populations; (2) case reports, editorials, or narrative reviews (though their references were checked); and (3) studies where data on abortion and *T. gondii* could not be separated from other infections.

Study Selection Process

Titles and abstracts of all identified papers were separately screened by two reviewers. Potentially eligible studies were then screened against the inclusion criteria with full texts obtained. Any disputes between reviewers were resolved through conversation to reach consensus.

Data Extraction and Management

Information was extracted from each eligible study using a standardised data extraction form including: 1) first author and year of publication, 2) place of the study (city/governorate), 3) study design, 4) sample size (cases and controls if applicable), 5) diagnostic methods used and main findings (seroprevalence of IgG and/or IgM, odds ratios or other measures of association).

Quality Assessment and Risk of Bias Analysis

The methodological quality of the included studies was appraised using a modified version of the Newcastle-Ottawa Scale or a similar checklist appropriate for observational studies. The assessment focused on the risk of bias in key domains, such as participant selection, comparability of groups, and ascertainment of exposure and outcome.

Data Synthesis Strategy

A formal meta-analysis was not planned due to predicted heterogeneity of study design, demographics and diagnostic procedures. Instead, the findings were synthesised narratively. The results were summarised and classified by geographical location within Iraq and focused on seroprevalence rates and any associated reports of *T. gondii* and spontaneous abortion.

Results

Study Selection and Screening Outcome

The original database search was associated with a large number of citations. Titles and abstracts were screened and duplicates were removed prior to selection of articles for full-text review. This systematic review comprised the last batch of primary researches conducted in Iraq based on the eligibility criteria. Reasons for exclusion were mainly animal populations, non-Iraqi populations or non-inclusion criteria study designs.

Characteristics of Included Studies from Iraq

The studies included in this review are a geographical cross section of Iraq , with studies conducted in key cities and governorates including Sulaimani (Kurdistan Region), Baghdad , Erbil (Kurdistan Region), Basra , Babylon , and Duhok (Kurdistan Region). The studies were mainly cross-sectional or case-control in design, published from 2019 to 2025. Serological methods, namely ELISA, were used in all the research to identify IgM and IgG antibodies against *T. gondii* differentiating recent/acute from chronic infections. Sample sizes vary, but combined they represent data on several hundred women who have had spontaneous abortion.

Seroprevalence of *Toxoplasma gondii* Across Iraqi Governorates

The results continuously show a significant seroprevalence of *T. gondii* in women with history of spontaneous abortion everywhere in Iraq. A 2023 study conducted in Erbil showed that 27.03% of aborted women exhibited signs of *T. gondii* infection, indicating the endemicity of the parasite in the Kurdistan Region. A research in Sulaimani in 2025 also reported a high rate among mothers with spontaneous abortion, strongly recommending routine screening. A study from Baghdad in 2024 revealed prevalence in aborted women and confirmed existence of infection as an important factor in the city. A study conducted in Basra in 2021 examined the TORCH agents and confirmed the seroprevalence of *T. gondii* in women who had experienced miscarriage. Studies conducted in 2019 and 2020 in Babylon Province employing IgM and IgG testing for infection status revealed high seroprevalence rates. In Duhok, a study in 2020 has shown the presence of *T. gondii* in blood and placental samples from aborted mothers, a direct indication of infection at the maternal-fetal interface.

Analysis of Identified Risk Factors for Infection

Though not the major focus of all studies examined, several explored potential risk factors linked with *T. gondii* seropositivity. The risk factors most frequently reported were in accordance with recognised transmission channels, such as contact with cats, ingestion of undercooked meat (barbecue or kebab), and drinking unpurified or untreated water.

Quality Assessment of Primary Studies

Overall, the methodological quality of the included studies was moderate. Most were cross-sectional in design which restricts the capacity to show a clear causal association between infection and abortion. Possible sources of bias included non-random sampling procedures and not controlling for confounding variables (other infections, genetic factors) in certain research. But the fact that their results are consistent across regions and periods of time increases the overall evidence foundation.

Discussion

Synthesis of Main Findings on Prevalence and Association

The present extensive analysis gives a solid proof that *Toxoplasma gondii* infection is quite common among women with spontaneous abortion in Iraq. In this regard, studies conducted in Erbil, Sulaimani, Baghdad, Basra and Babylon showed a strong connection between seropositivity to *T. gondii* and pregnancy loss [11]. However, the high prevalence rates in the target group (27.03% in Erbil) regardless of the fact that most studies could not establish causality due to the cross-sectional design, strongly suggested toxoplasmosis as a major, and likely under-diagnosed, contributor to the burden of spontaneous abortion in the country. The prevalence of both IgM and IgG antibodies in these people suggests acute and chronic/reactivated infections [12].

Interpretation of Findings in the Context of Pathophysiological Mechanisms

The parasite provokes a vigorous maternal inflammatory response, which, although attempting to control the infection, may disturb the finely tuned immunological milieu of the placenta [13]. This inflammatory cascade as well as the capacity of the parasite to directly infect and destroy placental and foetal organs provides a physiologically feasible explanation for the substantial relationship seen in the investigations. The results from Iraq thus provide a real-world validation of the biological pathways observed in immunological and experimental studies [14].

Comparison of Iraqi Data with Regional and Global Findings

Reported prevalence rates in Iraq are comparable and in some cases appear to be at the upper end of the spectrum reported in the larger Middle East [1,3,5]. For example, the results are comparable with data from neighbouring Iran where several investigations and a meta-analysis have confirmed *T. gondii* as a major cause of miscarriage. Also a comprehensive assessment of the WHO Eastern Mediterranean Region, indicated the severe impact of toxoplasmosis on maternal-fetal outcomes and stated that socio-political and living situations may worsen the problem [5]. The high incidence found could be explained by the years of violence, displacement and issues in public infrastructure in the Iraqi setting that could have created an environment permissive to the transmission of zoonotic diseases such as toxoplasmosis [15].

Clinical and Public Health Implications for Iraq

These results have major ramifications. The strong correlation between *T. gondii* and spontaneous abortion shows that many abortions in Iraq are likely avoidable. This provides a clear mandate for the public health system and clinical practitioners [16].

There is substantial evidence to support statements made by more than one of the Iraqi studies assessed that routine antenatal screening for *T. gondii* should be considered as part of usual care for pregnant women. Early diagnosis allows counselling and possibly therapeutic action to reduce the risk of congenital transmission or pregnancy failure. There is an urgent need for public health campaigns to educate women of reproductive ages about the dangers and routes of transmission of toxoplasmosis. The primary infection can be considerably decreased by easy preventive measures, such as cooking meat thoroughly, washing hands after handling raw meat or raw vegetables and avoiding contact with cat faeces [17].

Strengths and Limitations of the Review

The fundamental strength of this analysis is that it is the first to systematically synthesise the localised data of the topic from across Iraq, presenting a full national picture. Pooling data from several governorates makes a stronger case for a single public policy approach. However, this evaluation is constrained by the limitations of the main study covered. The prevalence of cross-sectional designs does not provide unambiguous determination of causal linkages. Furthermore, diagnostic methodologies and population sampling were varied across the studies. Furthermore, the review was restricted to papers published in English, which would have left out relevant studies published in Arabic or Kurdish in local publications. These limitations indicate the need for further rigorous research in the future.

Conclusion

Toxoplasma gondii infection is associated with spontaneous abortion in women in Iraq, and toxoplasmosis is considered a major public health concern impacting pregnancy outcomes, according to a systematic literature assessment.

Recommendations include routine serological screening of pregnant women, public awareness of transmission and prevention, clinical suspicion of toxoplasmosis in unexplained miscarriages and advice to all pregnant women on preventative techniques. Further work is needed via prospective cohort studies to confirm causation, standardise methodology and assess prevalent *T. gondii* genotypes in Iraq. It is a comprehensive method designed to minimise the economic and psychological impact on women and families involved in spontaneous abortion.

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