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Understanding Toxoplasmosis in Reproductive-Age Women: Determinants of Infection and Evidence-Based Mitigation Approaches

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Abstrak

Toksoplasmosis merupakan masalah kesehatan masyarakat yang persisten pada perempuan usia reproduktif karena memiliki risiko penularan kongenital dan berdampak berat pada janin. Tinjauan naratif ini bertujuan untuk mensintesis bukti terkini mengenai determinan infeksi serta mengevaluasi strategi mitigasi berbasis bukti, sekaligus mengidentifikasi kesenjangan yang masih ada dalam tingkat pengetahuan dan efektivitas intervensi. Penelusuran literatur dilakukan secara komprehensif melalui database PubMed dan Google Scholar terhadap artikel yang diterbitkan antara tahun 2016–2025. Hasil kajian menunjukkan adanya variasi seroprevalensi antarwilayah. Prevalensi yang lebih tinggi secara konsisten ditemukan pada perempuan usia lebih tua, multipara, tinggal di wilayah pedesaan, dan berpendidikan rendah. Faktor risiko utama meliputi konsumsi air terkontaminasi, daging kurang matang, serta praktik higiene yang buruk, sementara hubungan dengan kepemilikan kucing menunjukkan hasil yang tidak konsisten. Tingkat pengetahuan dan kesadaran tentang toksoplasmosis pada perempuan dan tenaga kesehatan umumnya masih rendah. Meskipun edukasi kesehatan dan skrining antenatal menunjukkan potensi manfaat, efektivitasnya belum dievaluasi secara optimal. Oleh karena itu, diperlukan strategi pencegahan yang terintegrasi dan kontekstual untuk menurunkan risiko infeksi dan mencegah toksoplasmosis kongenital.

Abstract

Toxoplasmosis remains a persistent public health concern among women of reproductive age due to the risk of congenital transmission and severe fetal outcomes. This narrative review aimed to synthesize recent evidence on infection determinants and evaluate evidence-based strategies to mitigate risks, addressing persistent gaps in awareness and intervention efficacy. A comprehensive literature search of PubMed and Google Scholar was conducted for studies published between 2016 and 2025. The findings reveal substantial geographic variation in seroprevalence, influenced by environmental conditions, cultural practices, and socioeconomic disparities. Higher infection rates were consistently reported among older, multiparous, rural, and less-educated women. Key risk factors included consumption of contaminated water, undercooked meat, and poor hygiene practices, while associations with cat ownership were inconsistent. Overall, knowledge and awareness of toxoplasmosis were low among women and healthcare providers. Although educational interventions and antenatal screening demonstrated potential benefits, their effectiveness remains insufficiently evaluated. Integrated, context-specific prevention strategies are urgently needed to reduce infection risk and prevent congenital toxoplasmosis.

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INTRODUCTION

Toxoplasmosis in premarital or reproductive age women has emerged as a critical area of inquiry due to the significant public health implications of Toxoplasma gondii infection during pregnancy. Globally, toxoplasmosis affects a substantial proportion of women of childbearing age, with seroprevalence rates ranging widely across regions, from 10.6% in Iran to over 80% in some African countries (Fenta, 2019; Gelaw et al., 2024; Nematollahi et al., 2022). The parasite's complex life cycle involving felines as definitive hosts and warm-blooded animals as intermediate hosts contributes to diverse transmission pathways, including ingestion of oocyst-contaminated water or food and undercooked meat (Alzaheb, 2018; Mizani et al., 2017; Serra et al., 2025).

Toxoplasma gondii infection can cause adverse events in fetal and neonatal outcomes associated with congenital toxoplasmosis, including miscarriage, neurological deficits, and long-term disabilities (Barzgar et al., 2024; Rabaan et al., 2023). Primary maternal infection during pregnancy risks transplacental transmission, with rates rising from 25% in the first trimester to 65% in the third, though early infections cause the most severe outcomes like miscarriage, chorioretinitis, hydrocephalus, microcephaly, intracranial calcifications, and long-term neurological sequelae. Symptomatic congenital cases manifest in 58.6% of untreated newborns, with 45% developing ophthalmological issues during follow-up (Garozzo et al., 2025; Salari et al., 2025).

Environmental factors, socioeconomic status, and individual behaviors collectively modulate infection risk in women of reproductive age, particularly across diverse geographic and cultural contexts (Cammarelle et al., 2025; Pramudya et al., 2025; Qadeer et al., 2025). Despite numerous studies on Toxoplasma gondii seroprevalence and risk factors in reproductive-age women, a lack of consensus persists regarding the relative importance of variables such as cat exposure, water source, dietary habits, and educational level. Moreover, conflicting findings emerge on behaviors like undercooked meat consumption or soil contact, with some studies linking raw meat and cat litter handling to higher seropositivity (OR up to 6-7), while others report no significant association with cat ownership, education, or eating habits (Cammarelle et al., 2025; Maqsood et al., 2021; Qadeer et al., 2025). These inconsistencies hinder targeted prevention strategies and public health policies. The consequences of this gap include continued high rates of congenital toxoplasmosis and missed opportunities for effective intervention during critical reproductive periods (Coelho et al., 2024; Tarekegn et al., 2020).

This review is important because toxoplasmosis poses significant health risks, particularly during pregnancy, including congenital transmission and adverse fetal outcomes. Understanding the interplay of environmental

exposures, socioeconomic conditions, and behavioral practices is critical for developing effective prevention and control strategies. This narrative review synthesizes recent evidence on infection determinants and evaluates evidence-based strategies to mitigate risks, addressing persistent gaps in awareness and intervention efficacy.

METHODS

This study adopted a narrative review design to summarize and integrate existing evidence on toxoplasmosis among women of reproductive age. The review focused on identifying environmental, socioeconomic, and behavioral determinants of Toxoplasma gondii infection, as well as mapping evidence-based prevention and mitigation approaches reported in the literature. A narrative review was selected to allow a comprehensive and contextual understanding across diverse study settings and populations.

A literature search was conducted across two major electronic databases, PubMed and Google Scholar. Searches included combinations of keywords and Boolean operators: “toxoplasmosis” OR “Toxoplasma gondii” AND “reproductive-age women” OR “women of childbearing age” AND “risk factors” OR “determinants” OR “behavior” OR “socioeconomic factors” OR “environmental exposure” AND “prevention” OR “intervention” OR “mitigation.” MeSH terms and truncations were applied when applicable to enhance retrieval.

Studies were included if they met the following criteria: (1) primary research articles published from 2016 to 2025; (2) no restriction for the study design; (3) study populations comprising women of reproductive age (15–49 years); (4) reporting environmental, socioeconomic, and/or behavioral determinants of toxoplasmosis; and (5) providing information on prevention or intervention strategies for Toxoplasma infection. To ensure adequate coverage of the available evidence, and due to the limited number of published studies explicitly specifying women of reproductive age as the study population, articles with pregnant women as the study sample were also included. Pregnant women were considered a relevant subgroup within the reproductive-age population, given their heightened vulnerability to toxoplasmosis and the significant implications of infection for maternal and fetal health.

RESULTS AND DISCUSSION

Seroprevalence Rates

Seroprevalence rates are defined as the proportion of a population that has detectable antibodies to a specific pathogen in serum samples, calculated as the number of seropositive cases divided by the total number if samples tested, and is expressed as a percentage. Seroprevalence is a quantitative method for measuring the extent of underreporting and can be used in conjunction with other routine

surveillance methods (Taylor et al., 2023). This indicator reflects cumulative exposure rather than active infection, as antibodies like IgG persist in lifelong post-infection (Arkhipova-Jenkins et al., 2021). Surveys using this metric reveal hidden burdens in asymptomatic groups, such as toxoplasmosis in pregnant women from rural areas.

Seroprevalence varied widely across regions, from as low as 4.2% in some African settings to over 80% in parts of Ethiopia and Nigeria, reflecting geographic and socioeconomic diversity (Daka et al., 2024; Fenta, 2019; Gelaw et al., 2024). Geographic disparities reflect differences in climate such as humid tropics favoring oocyst survival, cultural practices such as raw meat consumption, and access to healthcare, influencing exposure and vulnerability (Hamidi & Taghipour, 2024; Lima et al., 2024; Lozano et al., 2024; Shoukat et al., 2022). For instance, Latin America and sub-Saharan Africa exhibit combined rates of 40-85%, while Europe and certain regions of Asia demonstrate rates of 10-30% (Elzeblawy Hassan, 2017; Salari et al., 2025).

Higher seroprevalence was consistently observed among older women, multiparous women, and those with lower education levels (Alzaheb, 2018; Lozano et al., 2024; Mousavi-Hasanzadeh et al., 2020). Age-related increases align with prolonged environmental exposure, as IgG positivity rises progressively (e.g., 22.3% in younger vs. 31.4% in older Croatian women). Multiparity has been associated with repeated high-risk behaviors, such as frequent meat consumption or gardening. In addition, low education levels have been shown to amplify risks through poor hygiene awareness. This is evident in the 69.4% prevalence of poor hygiene among rural Iranian farmers compared to urban groups (Bahadori et al., 2025; Sviben et al., 2025). Conversely, many studies reported a substantial proportion of women remain seronegative (IgG-negative) and thus susceptible to primary infection during pregnancy, with the risk of congenital transmission up to 40% without intervention (Hamidi & Taghipour, 2024; Jafari-Shakib et al., 2024; Shahighi et al., 2021).

Determinants of Toxoplasmosis Infection

Environmental and behavioral risk factors such as cat contact, consumption of undercooked meat, untreated water, and rural residence as significant contributors to toxoplasmosis infection (Gelaw et al., 2024; Shoukat et al., 2022). However, some studies reported inconsistent associations with cat ownership. This suggests that direct contact or hygiene practices may be more critical than mere ownership (Aldali et al., 2024; Mustafa et al., 2019; Vueba et al., 2020). High cat density and poor water quality drive oocyst transmission, with cat ownership and direct litter handling linked to elevated infection rates, soil contact via gardening without gloves further increases risk in rural settings (Subrata et al., 2021).

Socioeconomic factors, including education level and rural versus urban residence were frequently linked to infection risk. Specifically,

lower education and rural living associated with higher prevalence (Alzaheb, 2018; Lima et al., 2024; Olarinde et al., 2022). Low education and income levels strongly correlate with higher Toxoplasma gondii seropositivity in reproductive-age women, as limited access to sanitation, health information, and resources amplifies exposure risks (Daka et al., 2024; Qadeer et al., 2025). These factors interact with behaviors, where low socioeconomic status hinders adoption of safe practices, perpetuating cycles of vulnerability in high-burden regions (Bahadori et al., 2025). Women with a lack of formal education exhibit a higher odd of infection compared to those with higher education ($\chi^2 = 68.683$, $p < 0.001$). This discrepancy can be attributed to a lack of knowledge regarding preventive practices, such as handwashing and produce cleaning. Illiteracy has been shown to independently elevates seroprevalence, with studies confirming this association after multivariate adjustment (Mareze et al., 2019; Qadeer et al., 2025). Furthermore, in rural areas, limited access to sanitation and veterinary services can lead to elevated levels of oocyst ingestion through soil gardening without gloves, consuming unwashed vegetables, eating raw meat and close animal proximity for rural residence (Bieńkowski et al., 2023).

These factors highlight the multifaceted transmission pathways of Toxoplasma gondii and emphasize the vulnerability of women in rural settings where such exposures are more prevalent. Furthermore, the literature reveals that behavioral practices relating to hygiene, food preparation, and animal contact are critical modifiable risk factors, yet are often inadequately addressed or understood by affected populations. Socioeconomic status and education appear to have a substantial influence on both seroprevalence and awareness levels. Lower educational attainment and rural residency are consistently associated with higher infection rates, reflecting disparities in access to information, healthcare services, and preventive resources. Despite the recognition of these associations, there remains a notable gap in linking knowledge to effective behavior change, as many women demonstrate low awareness of toxoplasmosis risk factors and transmission mode. This knowledge deficit extends to healthcare providers, further impeding the translation of theoretical understanding into practice.

Intervention Effectiveness

Planned or proposed interventions for toxoplasmosis prevention have largely focused on prenatal screening protocols and community-based health education, though empirical evidence on their effectiveness remains limited (Smit et al., 2017). Educational programs were shown to improve knowledge and preventive behaviors in some populations, highlighting the potential for awareness campaigns to mitigate risk (Coelho et al., 2024). Lower educational attainment and higher toxoplasmosis seroprevalence aligns with existing literature demonstrating that women with limited education tend to have

poorer awareness of transmission routes and preventive practices, which may increase their risk of infection (Alzaheb, 2018; Flores et al., 2021). These results reinforce the role of education as a key enabling factor for effective adoption of preventive behaviors during the reproductive period.

These educational programs have been shown to significantly enhance knowledge of transmission routes and hygiene practices, particularly among populations with low awareness. This improvement in knowledge has been demonstrated by pre-post assessments, which have shown increased attitudes ($\rho=0.177$, $p<0.01$) and support for precautions (63.7% endorsement). However, disparities persist, as only 28.8% of respondents recognize the value of prenatal screening, underscoring the necessity for tailored initiatives targeting younger, less-educated women (Qadeer et al., 2025).

Moreover, the higher infection rates observed among women from rural and socioeconomically disadvantaged backgrounds support prior evidence that toxoplasmosis risk is shaped by broader social and structural determinants (Aldali et al., 2024; Coelho et al., 2024; Lima et al., 2024). Limited access to health information, antenatal care services, and diagnostic facilities in rural settings may exacerbate gaps in knowledge and delay preventive interventions. This pattern underscores how socioeconomic gradients amplify infection risks, as disadvantaged groups often face intersecting barriers like inadequate sanitation, reliance on unfiltered water, and frequent contact with cats or undercooked meat. These factors are common vectors in low-resource contexts.

Lower educational attainment and rural residency are consistently associated with higher infection rates, reflecting disparities in access to information, healthcare services, and preventive resources. Few studies directly evaluated intervention outcomes for toxoplasmosis in reproductive age women, yet recent evidence emphasized the need for health education and antenatal screening as effective strategies to reduce infection risk (Akpan et al., 2023; Lozano et al., 2024; Shahighi et al., 2021). Furthermore, the findings in France, Austria, and Slovenia highlight the efficacy of maternal screening in reducing CT and in mitigating the effects of CT in affected newborns and children. Additionally, cost-benefit analyses have demonstrated that such prevention strategies are economically advantageous from both societal and budgetary perspectives (Bobić et al., 2019).

Knowledge and Awareness Levels

Knowledge about toxoplasmosis transmission and prevention was generally low among women of reproductive age, with many unaware of key risk factors such as cat exposure and undercooked meat consumption (Aldali et al., 2024; Coelho et al., 2024). Despite the recognition of these associations, there remains a notable gap in linking knowledge to effective behavior change, as many women demonstrate low awareness of toxoplasmosis risk factors

even in high-prevalence settings. A survey was conducted to assess the awareness of toxoplasmosis among pregnant women. The results indicated that only 22.4% of the participants were aware of the existence of this parasitic disease. Seventy-one percent of patients lacked awareness regarding the modes of transmission of toxoplasmosis (Eroglu & Asgin, 2021; Khan et al., 2023).

The implementation of pregnancy screening programs and educational programs aimed at increasing awareness and protection can serve as effective measures to prevent congenital toxoplasmosis (Eroglu & Asgin, 2021). Notably, positive attitudes toward learning and preventive behaviors were noted despite low baseline awareness, indicating receptiveness to education (Aldali et al., 2024). These approaches prove particularly promising in low-resource settings, where integrating screening into routine antenatal care.

A lack of knowledge has also been identified among healthcare providers, which may hinder the translation of theoretical understanding into clinical practice. A recent study has indicated significant knowledge gaps among healthcare providers, particularly in the domain of diagnostic interpretation. This finding underscores the necessity for professional training to address these deficiencies (Coelho et al., 2024).

Policy and Practice Integration

Several studies highlighted the gap between theoretical understanding of toxoplasmosis transmission and its translation into effective public health policies and practices (Alzaheb, 2018; Flores et al., 2021). Recommendations frequently included the implementation of routine antenatal screening, health education campaigns, and integration of toxoplasmosis prevention into maternal health programs (Akpan et al., 2023; Lozano et al., 2024; Vueba et al., 2020). Health policies should integrate routine toxoplasmosis risk assessment and counseling for women of reproductive age, including premarital and preconception care, to curb primary infections during pregnancy and enhance maternal-fetal outcomes (Shahighi et al., 2021; Yosef et al., 2024). Some regions lack mandatory screening and face challenges such as limited resources and low public awareness, impeding effective policy enactment (Alzaheb, 2018; Vueba et al., 2020).

In general, public health interventions focusing on antenatal screening and educational programs show promise but have been insufficiently evaluated for effectiveness. Where implemented, targeted education during pregnancy has improved knowledge and preventive behaviors, indicating receptiveness among women to adopt recommended practices. However, the integration of theoretical transmission models into intervention design is limited, reflecting an underutilization of robust frameworks that could enhance the development of comprehensive, context-sensitive mitigation strategies. Geographic heterogeneity in seroprevalence and risk profiles further necessitates tailored approaches that consider local

environmental conditions, cultural practices, and resource availability. Integration of One Health approaches, including monitoring of domestic animals and environmental reservoirs, can enhance surveillance and risk mapping, facilitating more effective community-level interventions and resource allocation.

CONCLUSION

Toxoplasmosis persists as a pervasive and geographically disparate public health concern, particularly among women of reproductive age, bearing profound consequences for maternal and fetal well-being. This review demonstrates wide geographic variation in seroprevalence, driven by differences in environmental conditions, cultural practices, and socioeconomic contexts. A significant proportion of women remain seronegative and, as a result, remain susceptible to primary infection during pregnancy, thus placing them at ongoing risk of congenital toxoplasmosis. The risk of infection is determined by a multifaceted interplay of environmental, socioeconomic, and behavioral factors. These factors include rural residence, low educational attainment, limited income, access to contaminated water sources, poor hygiene practices, and high-risk food and animal-contact behaviors. The observed inconsistencies in the reported role of specific factors, such as cat ownership or dietary habits, suggest that exposure intensity and hygiene practices are more critical than isolated risk factors. This observation emphasizes the need for context-specific risk assessment and prevention strategies.

Although educational interventions and antenatal screening programs show potential in improving knowledge and preventive behaviors, evidence on their sustained effectiveness remains limited, particularly among non-pregnant women of reproductive age. The persistent lack of awareness among both women and healthcare providers underscores a significant gap in translating knowledge into effective practice. These findings underscore the necessity for integrated, multi-level prevention strategies that address social and structural determinants alongside individual behaviors. The integration of toxoplasmosis education, risk assessment, and screening into premarital, preconception, and antenatal care—supported by One Health approaches that consider animal and environmental reservoirs—promises to reduce infection risk and prevent congenital toxoplasmosis.

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