Prevalence of Acute and Chronic *Toxoplasma gondii* Infection in the Iranian Women of Reproductive Age: A Systematic Review and Meta-Analysis of Data Published Between 2010 - 2024

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Abstract

Context: *Toxoplasma gondii* remains a global concern, especially in developing countries. This parasite is particularly important in women of childbearing age due to its increased risk of miscarriage and serious complications in the newborn.

Objectives: This systematic review and meta-analysis was conducted to determinet the serum prevalence of acute and chronic *T. gondii* infection in women of reproductive age in Iran.

Methods: The systematic search process was carried out from January 2010 to July 2024 through four English databases (PubMed, Scopus, Web of Science, and Science Direct) and two Persian databases (Magiran and SID) as well as Google Scholar as a specialized search engine for the article. Meta-analysis analysis was performed using a random effects model. Prevalence estimates and 95% confidence intervals were calculated for each study. Heterogeneity was evaluated using the I2 statistic. Egger and Begg's test was also used to assess the publication bias.

Results: A total of 869 records were retrieved, resulting in 28 studies including 13,177 individuals of reproductive age included in the meta-analysis for *T. gondii*-specific IgG and/or IgM antibodies. The seroprevalence of IgG and IgM antibody serum in women is 29% (95% CI: 23% - 34%) and 4% (95% CI: 3% - 5%) respectively. Egger's test results (P = 0.001) showed publication bias.

Conclusions: The prevalence of chronic (IgG) and acute infection (IgM) *T. gondii* in women of reproductive age in Iran is relatively high. Therefore, there is an urgent need for education to increase women's awareness.

Keywords: Toxoplasma, Seroprevalence, Meta-Analysis, Women

1. Context

Toxoplasma gondii remains a global concern, especially in developing countries. It is a zoonotic disease between humans and animals (1). The definitive host (feline) causes environmental pollution by releasing oocysts. High-risk groups, including pregnant women and immunocompromised people. Humans are infected with this parasite through the consumption of half-cooked meat, unpasteurized milk, direct or indirect contact with environmental oocysts, vertical transmission during pregnancy, blood transfusion, and organ transplantation (2).

The global prevalence of *T. gondii* varies (1% - 100%) (3, 4) under the influence of climatic conditions, host susceptibility and soil humidity, health conditions, eating habits, and general awareness level. The prevalence of contamination in the Middle East is approximately 30% to 50% (5), 27.8 % in Saudi Arabia (1), and 58.3 % in Turkiye (6).

This parasite is very important in women of reproductive age because it can cross the placental barrier during pregnancy, this infection in the first and

second trimester of pregnancy can cause consequences such as low birth weight, hydrocephalus, intracranial calcifications, and vertinochoroiditis in newborns ([7]). T Specifically, 15% of premature abortions and 66% of late miscarriages are attributed to infections, considering the importance of having children and the youth of the population, this issue is very important ([1]).

2. Objectives

Considering the important role of _T. gondii_ infection in neonatal complications as well as miscarriage ([8]), the present study was conducted to determine the serum prevalence of acute and chronic _T. gondii_ infection in women of reproductive age in Iran.

3. Methods

This study, a systematic review and meta-analysis across Iran, was designed and implemented to evaluate the prevalence of serum antibiotics in women of reproductive age. This meta-analysis study was conducted according to the guidelines and protocol of meta-analysis (PRISMA) ([9]), and its protocol was registered in PROSPERO.

3.1. Search Strategy

The systematic search process was carried out from January 2010 to July 2024 through four English databases (PubMed, Scopus, Web of Science, and Science Direct) and two Persian databases (Magiran and SID) as well as Google Scholar as a specialized search engine for the article. using the following keywords: ("_Toxoplasma_" OR "_Toxoplasma gondii_" OR "_T. gondii_" OR "toxoplasmosis") and ("prevalence" OR "seroprevalence" OR "epidemiology") and ("Reproductive age " OR " Women " OR "Students" OR, childbearing Age " "or "Newly Married") and ("Iran" or "Islamic Republic of Iran").

3.2. Eligibility Criteria, Study Selection, and Data Extraction

After collecting the documents and articles, their specifications and abstracts were entered into the reference writing software, and duplicates were removed by using this software as well as re-reading the titles. In the next step, by reviewing the titles and

abstracts, studies unrelated to the purpose of this research were excluded, and then from among the remaining studies, referring to the full text of the article, it was ensured that it was related to the purpose of the present study, and irrelevant items were removed. the reference list of specified studies was examined to find more related studies. In addition, to access the articles whose full text was not available through the databases, contact was made with the corresponding authors via e-mail to receive the full text of the articles. Inclusion criteria include: (1) Studies published in English or Farsi from January 2010 to July 2024; (2) all primary studies (cross-sectional-analytical and case-control) on the prevalence of _T. gondii_ in women; (3) original articles with a full bibliography English and Farsi languages; (4) studies whose information (sample size and number of positive cases; (5) studies conducted only on humans.

3.3. Meta-Analysis

Meta-analysis analysis was performed using random effects model ([10]). The random effects model was used to estimate the prevalence and 95% confidence intervals. The weight of each study was calculated and the heterogeneity of studies was checked using Cochran's test (with a significance level less than 0.1) and its combination using the I2 statistic (with a significance level greater than 50%) ([11]). Egger and Begg's test was also used to evaluate the publication bias ([12]).

3.4. Quality Assessment

Study quality was assessed using the Newcastle-Ottawa scale ([13]).

4. Results

As shown in Figure 1, we identified 869 retrieved records in the database search, and after removing duplicates and irrelevant items, 28 studies were finally included in the meta-analysis (Figure 1). Table 1 shows the characteristics of the studies reported in the systematic review and meta-analysis.

The results of the study showed that the prevalence of IgG and IgM antibody serum in women is 0.29 (95% CI: 0.23 - 0.34) (Figure 2A) and 0.04 (95% CI: 0.03 - 0.05) respectively (Figure 2B). Egger's test results (P = 0.001)
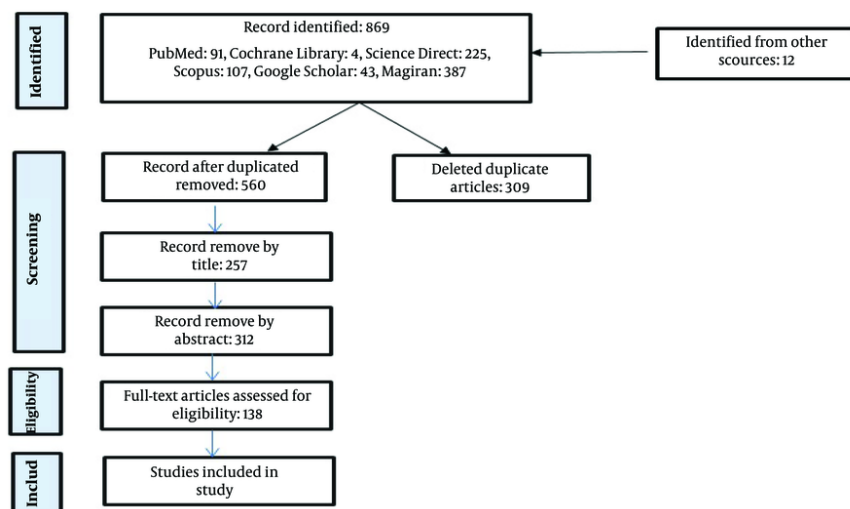
Figure 1. PRISMA graph of data retrieved from various databases based on inclusion and exclusion criteria

Table 1. Characteristics of the Selected Studies

Study	Year	Place of Study	Group	Method	Type of Study	N	Positive IgG	Positive IgM
Salehi et al. (14)	2022	Mashhad	Reproductive age	ELISA	Cross-sectional	417	80	8
Zeinali et al. (15)	2023	Northwest of Iran	Aborted	ELISA	Cross-sectional	215	70	3
Elyasi and Souizi (16)	2023	Razavi Khorasan	Newly married	ELISA	Cross-sectional	85	16	-
Nabizadeh et al. (17)	2022	Tabriz	Reproductive age	ELISA	Cross-sectional	2726	722	10
Saki et al. (18)	2021	Khuzestan	Aborted	ELISA	Cross-sectional	480	123	24
Rahimi-Esboei et al. (19)	2021	Mazandaran	Reproductive age	ELISA	Cross-sectional	500	133	21
Kalantari et al. (20)	2020	Fars	Students	ELISA	Cross-sectional	504	58	5
Naeini et al. (21)	2019	Chaharmahal and Bakhtiari	-	ELISA	Cross-sectional	20	13	1
Soltani et al. (22)	2018	Southwest of Iran	-	ELISA	Cross-sectional	253	139	18
Matin et al. (23)	2017	Ardabil	Aborted	ELISA	Cross-sectional	200	107	10
Sharif et al. (24)	2016	Mazandaran		ELISA	Cross-sectional	1178	662	
Tavakoli Kareshk et al. (25)	2016	Kerman	Childbearing age	ELISA	Cross-sectional	300	38	6
Mojadadi et al. (26)	2016	Sabzevar	Students	ELISA	Cross-sectional	137	18	0
Kamran et al. (27)	2015	Ilam	High school girls	ELISA	Cross-sectional	260	55	
Saki et al. (28)	2015	Ahvaz	Aborted	ELISA	Cross-sectional	130	34	1
Hooshyar et al. (29)	2015	Kashan	-	ELISA	Cross-sectional	434	123	7
Davami et al. (30)	2014	Jahrom	Newly married	ELISA	Cross-sectional	403	52	8
Fallah et al. (31)	2014	Ajabshir	High school	ELISA	Cross-sectional	402	88	66
Rajaii et al. (32)	2013	Northwest Iran	childbearing women	ELISA	Cross-sectional	1659	898	-
Davami et al. (30)	2013	Jahrom	Young women	ELISA	Cross-sectional	403	52	13
Maraghi et al. (33)	2013	Abadan	Students	ELISA	Cross-sectional	240	28	29
Mostafavi et al. (34)	2012	Isfahan	Childbearing age	ELISA	Cross-sectional	217	103	-
Heidari et al. (35)	2011	Gonabad	High school	ELISA	Cross-sectional	240	34	0
Mostafavi et al. (36)	2011	Isfahan	-	ELISA	Cross-sectional	300	109	-
Khazaei et al. (37)	2011	Zahedan	Before marriage	ELISA	Cross-sectional	280	-	15
Hashemi and Saraei (38)	2010	Qazvin	Before marriage	ELISA	Cross-sectional	400	136	-
Fouladvand et al. (39)	2010	Bushehr	High school	ELISA	Cross-sectional	491	114	7
Fouladvand (40)	2010	Bushehr	Before marriage	ELISA	Cross-sectional	303	71	10

showed publication bias. A funnel plot for detecting publication bias is shown in Figure 3.

5. Discussion

One of the important challenges of *T. gondii* infection is fetal and neonatal complications, and there is a need

for strategies to reduce this infection in women of reproductive age (41). Therefore, it is very important to investigate the contamination of women of reproductive age. Therefore, this current systematic review and meta-analysis was conducted to estimate the prevalence of *T. gondii* infection in women of reproductive age in Iran.
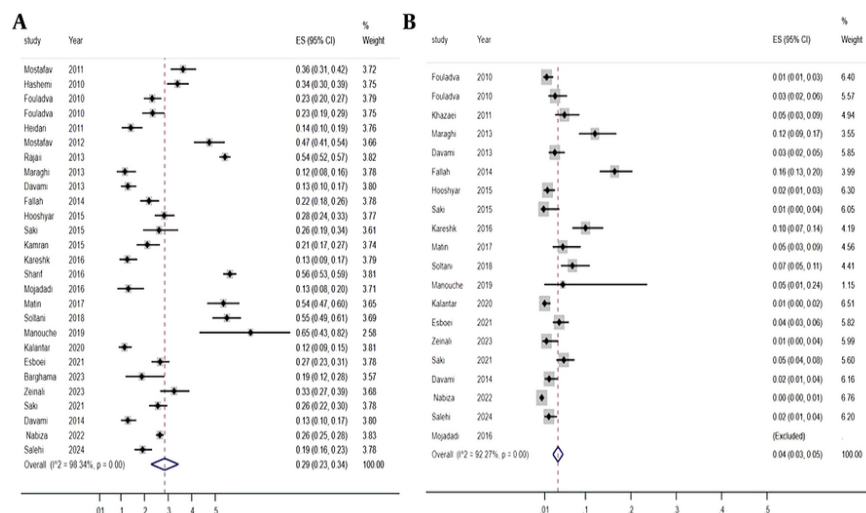
Figure 2. Forest plot of meta-analysis showing *Toxoplasma gondii* seroprevalence in women of reproductive age A, IgG; B, IgM.
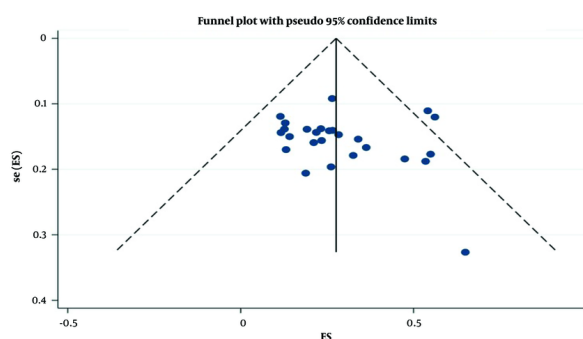

Figure 3. Funnel plot to detect publication bias

The present meta-analysis was performed using 28 published serological studies, with a sample size of 13,177 people. In this study, the serum prevalence of IgG *T. gondii* in reproductive age women is 29% (95% CI = 23% - 34%), which is consistent with the meta-analysis study conducted in Saudi Arabia 27.8% (95% CI = 20.6% - 36.3%) [1]. But compared to other countries around Iran, Iraq 52.6% [1], Turkey 58.3% [6], and a study conducted in Iran by Mizani 43% between 1994 - 2017 [42], it is lower this could be due to increased awareness and preventive measures against this parasite.

The seroprevalence of IgM in this study was 4% (95% CI = 3% - 5%), which is higher than the meta-analysis study conducted in Turkey (1%) [6], blood donors in Iran (1.4%) [43]. IgM indicates the acute form of *T. gondii* infection (instantaneous prevalence) in a way that it increases in the first week after exposure and then decreases [44] while IgG indicates a chronic infection (lifelong prevalence). What is important for preventing the problems and complications of *T. gondii* is the prevalence of the acute form of the disease.

Governments should seek to reduce its prevalence in women of childbearing age ([45]).

5.1. Strengths and Weaknesses

This study is the first meta-analysis that investigates the prevalence of acute and chronic *T. gondii* infection in women of reproductive age in Iran.

The most important limitations of this study: In this meta-analysis, the prevalence of *T. gondii* seroprevalence was only done in 18 provinces, and there were few studies in other provinces. Also, gray literature was not examined in this meta-analysis, the non-reporting of risk factors in many studies that did not allow meta-analysis of risk factors and the fact that in this study we only examined women of reproductive age and pregnant women were excluded from the study.

5.2. Suggestions

It is recommended that a comprehensive systematic review meta-analysis study be conducted in the entire Iranian general population to obtain a comprehensive estimate of the overall prevalence in the general population and to compare the prevalence rates in different population subgroups.

5.3. Conclusions

The results of this study showed that the prevalence of chronic (IgG) and acute infection (IgM) *T. gondii* in women of reproductive age in Iran is relatively high. However, considering the young population in Iran and the increased chance of fetal loss in pregnant women with the acute form of this infection, there is an urgent need for education about the complications of this infection, the ways of transmission and its prevention to increase women's awareness.

Footnotes

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