

## Highly Prevalence Of Feline Toxoplasmosis Sounds The Alarm In Iraq : A

### Review

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#### Abstract

Despite the substantial progress witnessed in the medical science and communicable diseases management, toxoplasmosis persists as a critical challenge facing global public health. this study attempted to provide an overview of the reality of the spread of this disease among cats and its implications for public health in Iraq .In this review, data collected from a total of 23 studies executed in different parts of Iraq from 2002 to 2025 about feline toxoplasmosis. The reviewed studies demonstrate high rates of infection with *Toxoplasma gondii* among Iraqi cats. stray cats showing higher prevalence than owned cats in most provinces. Furthermore, in some of these studies, a high infection rates documented among human coinciding with the high prevalence rates in cats especially among those who have direct contact with these animals .The results underscore the need for standardized diagnostic protocols, larger and more representative sampling, and integrated control programs to mitigate the zoonotic risk posed by *this* disease.

**Keywords:** *Toxoplasma gondii*, Feline Toxoplasmosis, zoonotic diseases

#### المخلص

على الرغم من التقدم الكبير الذي شهدته العلوم الطبية والسيطرة على الأمراض الانتقالية، لا يزال داء المقوسات يمثل تحديًا كبيرًا يواجه الصحة العامة العالمية. حاولت هذه الدراسة تقديم نظرة عامة على واقع انتشار هذا المرض بين القطط وتأثيراته على الصحة العامة في العراق. في هذه المراجعة، تم جمع البيانات من إجمالي 23 دراسة أجريت في أجزاء مختلفة من العراق من عام 2002 إلى عام 2025 حول داء المقوسات في القطط. أظهرت الدراسات التي تم مراجعتها نسب إصابة عالية بطفيلي المقوسة الكوندية بين القطط في العراق، مع انتشار أعلى بين القطط السائبة مقارنة بالقطط المملوكة في معظم المحافظات. علاوة على ذلك فقد رصدت بعض هذه الدراسات ارتفاعا في معدلات الإصابة بين البشر تزامنا مع ارتفاع معدلات الإصابة في القطط لاسيما بين أولئك الذين هم بتماس مباشر مع هذه الحيوانات. تؤكد النتائج على الحاجة إلى بروتوكولات تشخيصية موحدة، وأخذ عينات أكبر وأكثر تمثيلاً، وبرامج مكافحة متكاملة للتقليل من خطر انتقال العدوى الحيوانية المنشأ لهذا المرض. الكلمات المفتاحية: طفيلي المقوسة الكوندية داء المقوسات والأمراض المشتركة

#### Introduction

*Toxoplasma gondii* is an obligate, intracellular, alveolate coccidian protozoan parasite with global distribution due to its unique features. It capable of infecting almost all warm-blooded animals, including humans causing toxoplasmosis [1-2]. Domestic and stray cats (family Felidae) act as the definitive

hosts, excreting oocysts into the environment and thereby playing a main role in the epidemiology of toxoplasmosis, Approximately a third of the world's population is exposed to this parasite [3-5]. The second highest cause of human mortality associated with foodborne illnesses is *T. gondii* infection in USA [6]. Infection in humans is usually asymptomatic

but can cause severe disease in immunocompromised individuals and pregnant women[7].

#### Life cycle

The parasite completes its sexual reproduction only in cats. Infected cats shed oocysts in their feces. These oocysts become infectious (sporulated) after 1–5 days in the environment. Infection occurs when intermediate hosts (such as human) ingest sporulated oocysts from contaminated food, water, or soil [8]. In the intestine, oocysts release tachyzoites, which spread through the blood and tissues, causing acute infection. Later, they transform into bradyzoites inside tissue cysts (especially in muscles, brain, and eyes), leading to chronic infection[9-11]. Cats can become infected again by eating prey (birds/rodents) or tissues from other intermediate hosts carrying tissue cysts [12-13]. As well as many stages of parasite are infectious to human (oocysts, tachyzoites, and bradyzoites) and it can infect him by many ways [14-15]. Common ways of transmission include eating undercooked meat or organs containing tissue cysts from an infected intermediate host like sheep, pigs, deer or shellfish [8,16], ingesting food or water contaminated with cat feces (oocysts) [17-18] and Congenital transmission (mother to fetus) [19]. Less common routes involve transmission through drinking unpasteurized milk from some of an infected intermediate hosts especially milk of goat [20]. blood transfusion or organ transplantation from an infected donor[21]. In

rare cases, accidental laboratory exposure can also result in infection[22].

High population of stray cats, close contact between humans and domestic cats, and limited public health awareness in Iraq, contribute to the potential risk of *T. gondii* transmission [23-25]. This study attempts to provide an overview of the prevalence of *T. gondii* in cats across different Iraqi provinces and to assess its implications for public health. The objectives include

- collect and analyze data about feline toxoplasmosis from previous studies conducted in different Iraqi regions and over various time intervals
- compare prevalence rates between owned and stray cats in different places of the country.
- identify the diagnostic methods implemented in detecting *T. gondii* infection in these studies.
- explore the zoonotic importance of feline toxoplasmosis and its role in human infection

#### Methodology

This study was planned as a systematic review and comparative analysis of the prevalence of *T. gondii* infection in cats across different regions of Iraq. Consideration was given to both stray and pet cats. The methodological steps are listed below:-

#### Data collection

- Published articles, theses, and reports from 2000 to 2025 were searched through databases including PubMed, Google scholar, Research gate, and Iraqi academic journals.
- Search terms included: *Toxoplasma*

*T. gondii* in Iraqi cats, feline toxoplasmosis, cats toxoplasmosis in Iraq.

- Only studies reporting prevalence data in cats (owned or stray) with clear diagnostic methods were included.

#### Inclusion and Exclusion Criteria

- Included: research carried out in Iraq, using cats as the target host, with sample size, diagnostic technique, and prevalence rate clearly described.
- Excluded: Studies with inadequate methodological description, case reports, or studies on other hosts without feline data.

#### Data Extraction

The following variables were recorded for each study:

- Province of Iraq
- Year of publication
- Cat type (owned, stray, or mixed)
- Sample size
- Diagnostic method used :
  - Microscopy : direct and flotation techniques
  - Serological assays : latex agglutination test (LAT), enzyme-linked immunosorbent assay (ELISA), and modified agglutination test (MAT).
  - Molecular techniques : conventional PCR, nested PCR, real-time PCR, and PCR-RFLP assays.
- prevalence rate
- Citation/reference

#### Data Analysis

- Data collected from a total of 23 studies executed in different parts of Iraq from 2002 to

2025 about feline toxoplasmosis

- Prevalence data were tabulated and grouped according to province, type of cat and diagnostic method.
- In studies applying multiple diagnostic methods, results were documented separately.
- A comparative chart was also generated to illustrate the minimum and maximum reported prevalence rates per province.
- Microsoft Excel was used to analyze the results by paired t-test with charts.

#### Results

##### Prevalence of *Toxoplasma gondii* in Owned and Stray Cats in Iraq

Recent studies have confirmed the widespread occurrence of *T. gondii* in both owned and stray cats across different provinces of Iraq. In Baghdad, infection rates in stray cats reached 62.42% by LAT and 68.08% by nested PCR [26]. In contrast, domestic cats showed lower prevalence, ranging from 7.14–23.8% by microscopic flotation to 20% by PCR [27]. In Erbil, seroprevalence among 100 stray cats was 22% (MAT), 20% (ELISA), and 11% (LAT) [28].

A study in Baghdad revealed a significantly higher prevalence among cat owners (30%) compared to non-cat owners (17.5%), and higher rates in stray cats (22.5%) than in domestic cats (10%) [24]. Using fecal microscopy, the prevalence in mixed populations of domestic and stray cats in Baghdad was 3.31% [29].

In Basra province, microscopic and

concentration methods indicated a prevalence of 11.7% [30], while another study using the Toxo IgG/IgM Rapid test reported 33% positivity [34]. In Mosul, all 45 stray cats tested were positive by LAT (100%), while 26.6% were positive by ELISA (IgG), with molecular confirmation [31].

In Al-Anbar, owned cats showed a prevalence of 3.5% and stray cats 14.3% by microscopy, while Real-time PCR revealed a much higher infection rate (86.95%) [32]. In Kirkuk, PCR-RFLP (GRA6 gene) showed 6% infection in owned cats [35], whereas microscopy detected 8.33% in stray cats [46]. In Wasit, microscopy revealed a prevalence of only 1.42% [25].

Older studies further confirm the presence of *T. gondii* in cats across Iraq, with prevalence rates ranging from 3.75% in Baghdad [43] to 72.2% in stray cats by IHA [39] and up to 68% by LAT [37]. Details are presented in Table 1.

#### Range of Prevalence Across Provinces

Overall, infection rates in Iraq showed wide variability, ranging from 1.42% in Wasit (microscopy) to 86.95% in Al-Anbar (PCR) (Table 2, Figure 1). The variability is largely attributable to differences in cat type (owned vs. stray), diagnostic method, and sampling region.

#### Comparison Between Owned and Stray Cats

Most studies investigated either owned or stray cats. Therefore, comparison was limited to provinces where both types were studied: Baghdad, Al-Anbar, and Kirkuk (Figure 2):

- Baghdad: Stray cats exhibited much higher prevalence (~68%) compared to owned

cats (~24%).

- Al-Anbar: Stray cats (14.3%) also exceeded owned cats (3.5%).
- Kirkuk: A small difference was observed (8.33% vs. 6%).

A statistical comparison using an independent t-test yielded a p-value of 0.424, which is higher than the threshold ( $p < 0.05$ ). This indicates that the observed differences between owned and stray cats across these provinces were not statistically significant. However, this result must be interpreted cautiously due to reliance on published prevalence rates (not raw data) and the limited number of provinces ( $n = 3$ ).

Descriptive results suggest that stray cats carry a higher burden of *T. gondii* than owned cats, particularly in Baghdad and Al-Anbar. On average, owned cats showed a prevalence of ~11.1%, while stray cats averaged ~30.2%, although with wide variability. These findings underscore the potential epidemiological role of stray cats in environmental contamination and zoonotic transmission (Figure 3).

#### Discussion

The present review highlights the considerable variability in the prevalence of *T. gondii* among owned and stray cats in Iraq, reflecting differences in geographic region, diagnostic techniques, and cat lifestyle. Reported prevalence ranged from as low as 1.42% in Wasit (microscopy) [25] to as high as 86.95% in Al-Anbar (Real-time PCR) [32]. Such a broad range is consistent with the use of diverse diagnostic approaches, where molecular

and serological assays generally detect higher infection rates than conventional microscopic examinations [26, 27, 32].

### Owned vs. Stray Cats

The comparison between owned and stray cats in provinces where both were studied (Baghdad, Al-Anbar, and Kirkuk) demonstrated a consistent descriptive trend of higher prevalence in stray cats. In Baghdad, stray cats reached up to 68% [26], compared to ~24% in owned cats [27]. In Al-Anbar, stray cats (14.3%) exceeded owned cats (3.5%) [32]. In Kirkuk, however, prevalence was relatively similar (8.33% vs. 6%) [35, 45]. These findings support the hypothesis that stray cats, due to their outdoor lifestyle, hunting behavior, and lack of veterinary care, are more frequently exposed to *T. gondii* oocysts and intermediate hosts than owned cats. Despite this clear descriptive trend, the statistical comparison (independent t-test) across the three provinces revealed no significant difference ( $p = 0.424$ ). This result should be interpreted with caution, as the analysis was based only on reported prevalence rates, not raw data, and involved a small sample size ( $n = 3$  provinces). Additionally, differences in diagnostic methods across studies may have introduced variability that masked statistical significance.

### Regional Variation

Marked variation in prevalence was observed across Iraqi provinces. For instance,

Baghdad consistently reported high infection rates in stray cats (62–68%) [26], while Basra (11.7–33%) [30, 34] and Wasit (1.42%) [25] showed lower prevalence. Mosul reported extremely high seropositivity by LAT (100%) [31], contrasting with lower ELISA positivity in the same samples (26.6%), reflecting differences in test specificity and sensitivity. Older studies also showed high prevalence, such as 72.2% in stray cats in Baghdad by IHA [38] and 68% by LAT in multiple provinces [36]. These findings underline the influence of local environmental conditions, diagnostic tools, and sampling strategies on prevalence estimates.

### Diagnostic Methods

The results clearly demonstrate that diagnostic methods strongly influence prevalence estimates. Microscopic examination often reported the lowest rates (1.42–14.3%) [25, 32], while PCR and Real-time PCR showed markedly higher prevalence, up to 86.95% [32]. Serological tests such as LAT, ELISA, and MAT produced intermediate to high values, depending on the population studied [26, 28, 31]. These findings are consistent with international observations that molecular methods are more sensitive for detecting *T. gondii* DNA, while serology captures both past and current infections.

### Public Health Implications

The high prevalence in stray cats, particularly in Baghdad and Al-Anbar, highlights their role as important reservoirs of *T. gondii*, capable of contaminating the environment with oocysts. Although owned cats generally show lower

infection rates [24, 27, 35], they still pose a risk, particularly when allowed outdoors or fed raw meat. The results suggest that control strategies should focus on limiting stray cat populations and promoting responsible cat ownership to reduce environmental contamination.

### Conclusion

- *Toxoplasma gondii* infection in cats is widespread across Iraq, with prevalence rates varying depending on the region and diagnostic method.
- Stray cats exhibit higher infection rates than owned cats, reinforcing their role as the main source of environmental contamination.
- The parasite is endemic in Iraq, posing a continuing public health risk, especially for vulnerable human populations.

### Recommendations

1. Diagnostic improvement: Employ standardized and sensitive molecular and serological techniques in future studies.
2. National surveillance: Establish a monitoring system for *T. gondii* prevalence in cats across Iraq.
3. Stray cat management: Implement control measures to reduce stray populations.

4. Public health education: Promote awareness of toxoplasmosis risks and preventive practices.
5. One Health collaboration: Encourage cooperation between veterinary, medical, and public health sectors to mitigate zoonotic transmission.

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**Table (1).**The older studies about the spread of *T.gondii* among cats in Iraq

Regions	observations	Researchers
One study was conducted in Baghdad, Al-Najaf and Thi-Qar Provinces	The infection rates of <i>T. gondii</i> in local house cats by using three different tests , microscopic examining of fecal specimens, indirect Immunofluorescent antibody technique and LAT were 27.3% , 36.4% and 68% respectively.	[36 ].
Baghdad	<i>T. gondii</i> oocysts were observed microscopically in 30% of fecal samples collected from local housed cats	[37 ].
Baghdad	The analysis of stray cats sera by indirect haemagglutination test (IHA) revealed that the seroprevalence rate of <i>T. gondii</i> was high (72.2%)	[38 ].
Mid-Euphrates governorates (Babylon ,Najaf and Diwanyia)	The seropositivity rate of <i>T. gondii</i> in rural habitant cats by using LAT was 58%. While in urban habitant cats was 38.98	[39].
Diwanyia Province	Six blood samples collected from stray cats in the street of city center , all of them were positive for both tests LAT and ELISA, except one cat was negative to ELISA (IgG) only	[40].
The study was implemented primarily in Baghdad but also in North and West Iraq	A latex agglutination test applied, antibodies against <i>T. gondii</i> were recorded in 30.4% (63/207) of the cats. Cats from Baghdad had a lower seroprevalence (26.4%, 33/125) than cats from West Iraq (29.6%, 8/27) and cats from North Iraq (40%, 22/55)	[23].
Baghdad Province	ELISA-IgG test was conducted on stray cats, seropositive result of <i>T. gondii</i> was noticed in 66% (33 /50)	[41].
Baghdad	Microscopic examining of fecal specimens showed that 3.75% of house and stray cats were harbored <i>T. gondii</i>	[42].
AL- Nassaryia city of Thi – Qar province	<i>T. gondii</i> oocysts was detected in 94/200 (47%) of cats by fecal sedimentation technique	[43].
Salah -Aldin province	The direct examination of stray cats feces samples demonstrated that the rate of infection with <i>T. gondii</i> was 10.97%	[44].
Kirkuk Province	8.33% of stray cats were infected with <i>T. gondii</i> according to the results of microscopic examination of fecal samples	[45].

**Table 2:** Range of prevalence of *T. gondii* in cats in Iraqi provinces with type of cats and diagnostic methods

Province/City	Cat Type	Prevalence (%)	Diagnostic Methods
Baghdad	Stray, Owned, Mixed	3.31 – 68	Microscopy, LAT, PCR (B1), Serology
Erbil	Stray	11 – 22	MAT, ELISA, LAT
Basra	Mixed	11.7 – 33	Microscopy, Concentration, Rapid Test
Mosul	Stray	26.6 – 100	LAT, ELISA, PCR
Al-Anbar	Owned, Stray	3.5 – 86.95	Microscopy, Real-time PCR
Kirkuk	Owned, Stray	6 – 8.33	PCR-RFLP (GRA6), Microscopy
Wasit	Mixed	1.42	Microscopy
Najaf	Mixed	38 – 58	LAT
Thi-Qar	Mixed	47	Fecal sedimentation
Salah-Al-Din	Stray	10.97	Microscopy
Diyala	Stray	100 (6/6 samples)	LAT, ELISA
Mid-Euphrates (Babylon, Najaf, Diwaniya)	Mixed	38.98 – 58	LAT
Diwaniya	Stray	100 (5/6 samples)	LAT, ELISA

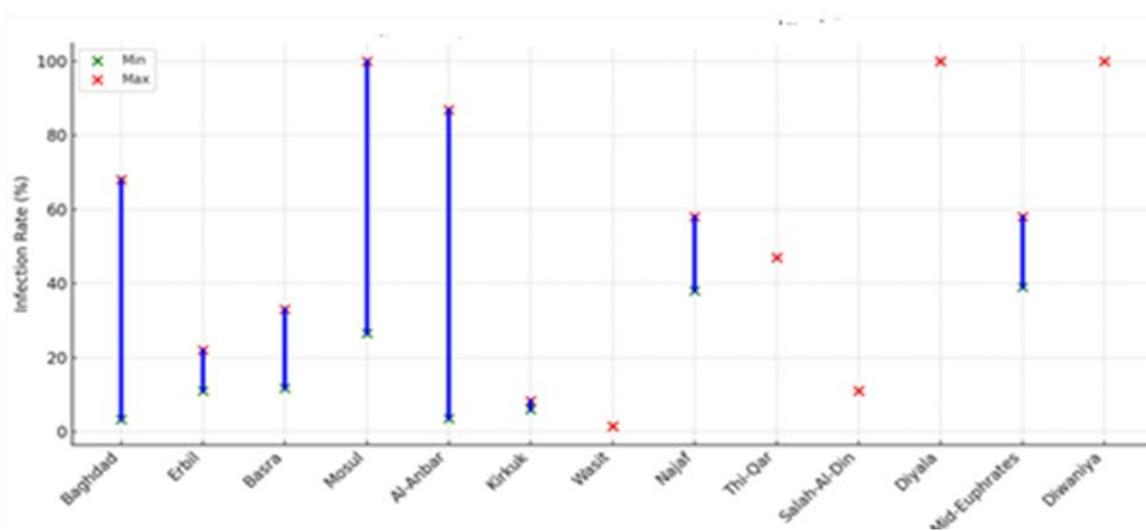


Figure1 : The range of *T. gondii* prevalence in cats across Iraqi provinces.

- The **green point** = lowest reported rate.
- The **red point** = highest reported rate.
- The **blue line** connects them, showing the spread range for each province.

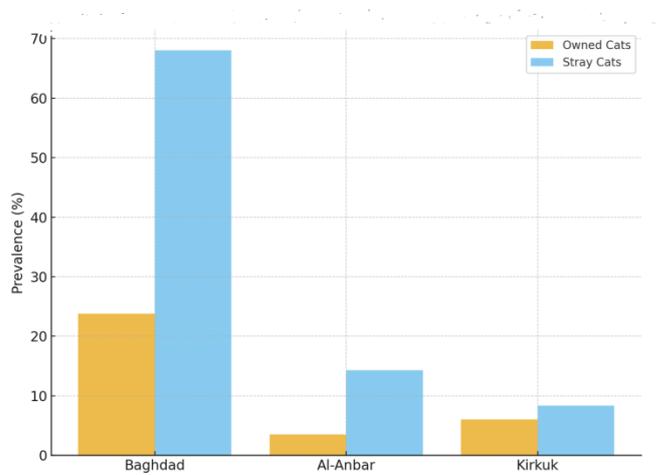


Figure2: the comparison of *Toxoplasma gondii* prevalence between owned and stray cats in the provinces where data were available for both types (Baghdad, Al-Anbar, Kirkuk). **t-statistic:** -0.95 , **p-value:** 0.424

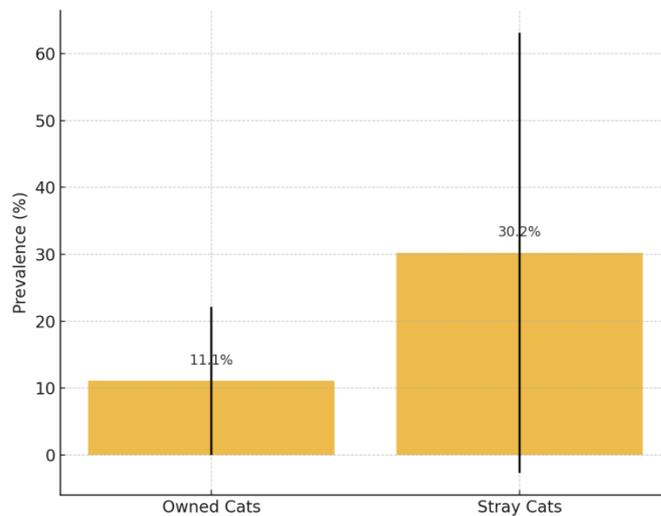


Figure3: The **average prevalence of T. gondii** in owned vs. stray cats across Baghdad, Al-Anbar, and Kirkuk, with **error bars ( $\pm$ SD)**.