



## Seroprevalence of *Toxoplasma gondii* Among Wild Rats (*Rattus rattus*) in Ahvaz District, Southwestern Iran

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### ABSTRACT

**Background:** The protist pathogen *Toxoplasma gondii* infects humans and other animals such as wild rats (*Rattus rattus*) worldwide. Wild rats are infected with *T. gondii* due to ingestion of food or water contaminated with oocysts and may play an important role in the transmission of *T. gondii* infection to humans.

**Objectives:** The aim of the present study was to determine the seroprevalence of *T. gondii* among wild rats in Ahvaz district, southwestern Iran.

**Materials and Methods:** We determined the seroprevalence of *T. gondii* among wild rats (*R. rattus*) in Ahvaz district between February 2008 and January 2011. Immunochromatographic assay (ICA) to detect serum antibodies against *T. gondii* was performed for 127 adult wild rats. The rats were captured in cages and brought alive to the Veterinary Hospital of Shahid Chamran University. The rats were classified according to sex and season and region of capture. The results were analyzed by Chi-square analysis and Fisher's exact test.

**Results:** Thirty-one of the 127 serum samples (24.41%) had antibodies against *T. gondii* (95% Confidence interval; 16.9–31.9%). Prevalence was higher in female rats (24.66%) than in male rats (24.07%). The rats caught during summer (34.48%) and in the east region of Ahvaz district (36.36%) showed high prevalence. However, the gender, season and region of collection did not significantly affect the prevalence of infection ( $P > 0.05$ ).

**Conclusions:** Our study showed that the seroprevalence of *T. gondii* was relatively high (24.41%) among wild rats in the Ahvaz district of Iran. The high prevalence of *T. gondii* infection in rodents may be of epidemiological importance as infected rodents are a potential route for *T. gondii* transmission to Felidae via ingestion of tissue cysts.

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### ► Implication for health policy/practice/research/medical education:

The rodents are mainly infected with *Toxoplasma gondii* by ingestion of food or water contaminated with oocysts, so they may play an important role in the transmission of infection.

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## 1. Background

*Toxoplasma gondii* is an intracellular coccidian parasite and causes one of the most common parasitic diseases of animals and man. Members of the *Felidae* family (mainly domestic cats) are the definitive hosts for this parasite. *T. gondii* is of primary importance since the range of intermediate hosts that it can infect encompasses virtually all warm-blooded animals, including man (1, 2). Usually, in-

gestion of encysted organisms present in the tissues of a chronically infected intermediate host leads to *T. gondii* infections in cats (3, 4). Intermediate hosts (e.g., rodents, birds, sheep, pigs, and cattle) may become infected due to ingestion of sporulated oocysts. *T. gondii* infection has become a major global public health concern in recent times due to the human immunodeficiency virus/acquired immunocompromised deficiency syndrome pandemic (5, 6). Fatal attraction has been reported in rats infected with *T. gondii* (7). It has been showed that the mean diameter of tissue cyst grew become stable and some may get compacted and lesser during the first three months and after four months in laboratory mice (8).

Three species of the genus *Rattus* have been reported from Iran: the brown rat (*Rattus norvegicus*), the black rat (*R. rattus*), and the Himalayan rat (*R. pectoris*) (9). Rats are herbivores and therefore, are susceptible to *T. gondii* infection due to ingestion food or water contaminated with oocysts (1, 10). The determination of the prevalence of *T. gondii* infection in rodents may be of epidemiological importance because rodents can serve as sources of tissue cysts for *Felidae* (2, 11). In Iran, large numbers of wild rats are found on residential streets. Wild rat populations are potentially an important host reservoir for the transmission of zoonotic parasites such as *T. gondii*. Previous studies have shown that the prevalence of *T. gondii* antibodies in the wild rats' population is quite variable (1-30%), depending on the method, number of animals studied and the geographic area (12).

Several laboratory methods have been developed to detect antibodies in the serum of infected rats, such as polymerase chain reaction, enzyme-linked immunosorbent assay, latex agglutination test, indirect hemagglutination assay (IHA), indirect fluorescent antibody test, microscopic agglutination test, and Sabin-Feldman dye test. Although these tests appear to be sensitive and specific, they are expensive and need to be performed in specialized laboratories. Immunochromatographic assay (ICA) is a rapid, simple, sensitive, and specific assay suitable for the diagnostic detection of specific antibodies against *T. gondii* in animals under field conditions (13). The Quicking *Toxoplasma* antibody rapid test kit (Toxo Ab test; Catalog No. W81042, Biotech Co., Ltd., Shanghai) is used for the qualitative detection of *Toxoplasma* antibody in animal's serum. Specificity and sensitivity for the Toxo Ab test kits were found to be 98% and 100%, respectively, when the tests were performed according to the manufacturer's instructions. In Iran, the epidemiology of toxoplasmosis has not been extensively investigated, and few data are available on the distribution and prevalence of the disease in wild rats (8).

## 2. Objectives

The objective of the present survey was to investigate the seroprevalence of *T. gondii* in wild rats in Ahvaz district, southwestern Iran. This study concluded that wild rats represent a significant and persistent wildlife inter-

mediate host reservoir for toxoplasmosis.

## 3. Materials and Methods

### 3.1. Study Area and Sample Population

This study was performed in Ahvaz district, southwestern Iran; a region situated 12 meters above sea level with a warm-humid climate. Between February 2008 and January 2011, levels of serum antibodies against *T. gondii* were measured in 127 adult wild rats (*R. rattus*) (73 female rats and 54 male rats) by performing ICA. The wild rats were captured using rat traps set in different locations and brought alive to the Veterinary Hospital of Shahid Chamran University. The age of the captured rats were not recorded. The rats were killed by an overdose of halothane and ether in a closed chamber. The thoracic cavity was opened, and blood was collected from the heart for serological studies after which the rats were necropsied. Sera were obtained by centrifugation at room temperature (25°C) at 1800 g for 10 minutes and were stored at -20°C until serological analyses were performed. Rats were classified according to gender and the season and region of capture (north, east, west, south, and central). All data were recorded and stored in a computerized database.

### 3.2. ICA and Interpretation of the Test

*T. gondii* antibodies were detected using a commercial rapid test kit (Toxo Ab test; Catalog No. W81042, Biotech Co., Ltd., Shanghai). The Toxo Ab test is a simple and rapid diagnostic test for *Toxoplasma* infection based on the principle of immunochromatography on filter paper. The kit is a lateral-flow immunoassay for the qualitative detection of *Toxoplasma* antibodies in serum samples from animals. This method has been widely accepted in various fields of laboratory diagnosis, including diagnosis of infectious diseases. ICAs are based on the formation of an immune-complex of antigen with antibody. In the Toxo Ab test, only 1 band within the result window indicates a negative result, and 2 colour bands (C and T) within the result window indicate a positive result.

### 3.3. Statistical Analysis

Chi-square test and Fisher's exact test were used for statistical analysis. Differences were considered significant when  $P < 0.05$ .

## 4. Results

The results of ICA showed that the prevalence of *Toxoplasma* infection among the Ahvaz district wild rat population was 24.41% (31 out of 127 serum samples; 95% confidence interval: 16.9-31.9%), indicating that this parasite is present in the ecosystem. *T. gondii* prevalence was higher among female rats (24.66%) than among male rats (24.07%). The prevalence was high for rats captured in the summer season (34.48%) and for rats captured from the east region (36.36%), but no significant differences in the prevalence of infection were identified between genders,

**Table.** Prevalence of *T. gondii* Infection Among Wild Rats (n = 137) Captured in Different Seasons and Regions of the Ahvaz District, Iran, as Determined by Immunochromatographic Assays

	Spring, No.		Summer, No.		Autumn, No.		Winter, No.	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
North	5	1	2	0	6	2	2	1
East	4	3	2	2	4	1	4	2
West	6	0	4	3	8	1	2	1
South	7	2	4	3	9	1	5	2
Central	5	0	7	2	7	3	3	1
Total	27	6	19	10	34	8	16	7

seasons, or regions of capture ( $P > 0.05$ ). Prevalence in other seasons (winter, spring, and autumn) was 30.44%, 18.18%, and 19.05%, respectively. Prevalence in other regions (north, west, south, and central) was 21.05%, 20%, 24.24%, and 21.43%, respectively. These results are summarized in Table 1.

## 5. Discussion

Toxoplasmosis is one of the most widespread infections in man and animals. To our knowledge, this is the first report on the prevalence of *T. gondii* in wild rats (*R. rattus*) in Ahvaz district and shows that 24.41% of the rats in this district were infected by *T. gondii*. The results of this research suggest that a considerable percentage of wild rats in southwest Iran (Ahvaz) are infected. These infected rats may play an important role in the transmission of toxoplasmosis to other animals, particularly cats, which are the definitive host. The climatic conditions in this area (warm and humid) appear to be suitable for the spread and survival of the oocysts.

Sampling was conducted in wild rats for nearly 3 years so the results can be considered representative for the wild rat population in the Ahvaz district. Although we observed a higher seroprevalence in female wild rats than in male wild rats, the difference was not significant ( $P > 0.05$ ). In a previous similar study conducted by Yinn *et al.* in China, all of the infected rats (3.2%; 7 out of 217) were female. No *T. gondii* antibodies were detected in male rats (14). In contrast, in a study by Salibay and Claveria in the Philippines, the *T. gondii* infection rate was higher in male rats than in female rats, and those caught in the commercial site had 100% seropositivity (15). A study by Webster showed no significant age, sex, or site differences in *T. gondii* prevalence between or within wild rat populations irrespective of habitat type or presence of cats (16).

In the present study, the association between the presence of infection and gender and collection site was not significant ( $P > 0.05$ ). Other studies have also shown that gender is to be a determining factor for *T. gondii* prevalence. Regarding seasonal variations in the prevalence of *Toxoplasma*, seasonal effects on the infection rate may reflect both climatic changes, which affect the parasite, as well as changes in the photoperiod, which influence the

host's physiology (3). In the present study, no significant differences were observed in the prevalence in different seasons and regions ( $P > 0.05$ ). A previous study on the prevalence of *T. gondii* in stray cats in the Ahvaz area reported that 59.4% (60 out of 101) of serum samples were positive according to the direct agglutination test. In that study, 48.5% and 51.5% of the positive serum samples were obtained from female cats and male cats, respectively. The number of positive male cats and female cats were not significantly different (17).

*Toxoplasma* antibodies were detected in 49.6% of healthy persons and in 72.3% of the suspected patients of toxoplasmosis in the Ahvaz area (17). The prevalence of *T. gondii* among rodent populations in different areas of the world have been investigated. These studies have reported infection rates of 3.2% (7 out of 217) in China (14), 0.8% (2 out of 238) in Grenada, West Indies (18), 58% (for *R. norvegicus*) and 42.0% (for *R. rattus mindanensis*) in the Philippines (15), 35% (82 out of 235) in the UK (16), and 0.3% (2 out of 588 for house mice, *Mus musculus*), 0% (for the genus *Peromyscus*) and 0% (for Norway rats, *R. norvegicus*) in Iowa, USA (19). The role of the domestic rat, *R. alexandrinus* as a reservoir host of *T. gondii* in Egypt has also been reported (20).

Dubey and Frenkel summarized the worldwide prevalence of *T. gondii* in different species of rats and concluded that the prevalence of viable *T. gondii* in *R. norvegicus* was generally low (11). One exception to this finding was reported in rats from an endemic area in Costa Rica where viable *T. gondii* was isolated from 15 of 120 rats (21). In contrast, Weigel *et al.* isolated *T. gondii* from only 1 of the 107 rats collected from 47 pig farms in Illinois, USA (22).

Our findings suggest that *T. gondii* is prevalent among wild rats in the Ahvaz district of Iran and that wild rats are important in the epidemiology of *T. gondii* in this area. Franti *et al.* found that 4% rats and house mice in Northern California, USA presented antibodies to *T. gondii* by IHA (23). Smith and Frenkel detected a *T. gondii* seropositivity rate of 3% among mice and rats in Missouri and Kansas, USA (24). In surveys performed among field rodents (*Apodemus agrarius*) in Korea, 15 of 1008 rodents were seropositive for *T. gondii* antibodies (10). In Panama City, Frenkel *et al.* found that 53 of 226 *R. norvegicus* rats had antibodies to *T. gondii* (25). In another study, sera

from 105 apparently healthy Anatolian ground squirrels (*Spermophilus xanthophrymnus*) were tested for *T. gondii* antibodies. Twelve out of the 105 (11.4%) squirrels were found to be seropositive for *T. gondii* antibodies (26). Our results for antibody detection of *Toxoplasma* in wild rats were similar to those of previous surveys conducted by Webster (16). Wild rats can be an important source for the transmission of zoonotic parasites such as *T. gondii* to cats.

Although prevention efforts should focus on educating cat owners about the importance of collecting cat feces in litter boxes, spaying cats, reducing the numbers of feral cats, cooking all meats, and promoting rigorous hand hygiene, reducing the numbers of wild rats is also important for control of toxoplasmosis (27). This is the first extensive survey of *T. gondii* infection among wild rats in the Ahvaz district, southwestern Iran, and the results have public health implications in this region. We think that further studies should be conducted to determine whether any host reservoirs exist amongst domestic and wild animals in this area, in which the disease was previously not found. This study will be the basis for further studies that will deepen our knowledge of the epidemiology of *T. gondii*. More extended studies are required to determine the seroprevalence rates among populations of wild rats and other wild animals in difference areas, and the implications of *T. gondii* prevalence on both animal and human health.

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