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Original paper

Seroprevalence of toxoplasmosis in Kermanshah City, west of Iran

Hamed KALANI[1], Fereshteh MOHAMMADI[2], Roghiyeh FARIDNIA[3], Farzaneh MIRZAEI[4], Stela VIRGILIO[5], Peyman HEYDARIAN[6], Fatemeh NAGHIPOUR-BORJ[7], Seyede-Elham BADIEE[8], Mahdi BAKHTIARI[9], Mohammad Ali MOHAGHEGH[8,10]

[1]Infectious Diseases Research Center, Golestan University of Medical Sciences, Gorgan, Iran
[2]Department of Parasitology and Mycology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
[3]Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran
[4]Department of Medical Parasitology and Mycology, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[5]Department of Cell and Molecular Biology, Ribeirao Preto Medical School, University of Sao Paulo, Ribeirao Preto, SP, Brazil
[6]Department of Medical Parasitology, School of Medicine, Qazvin University of Medical Sciences, Qazvin, Iran
[7]Kalat Healthcare Center, Mashhad University of Medical Sciences, Mashhad, Iran
[8]Department of Laboratory Sciences, School of Paramedical Sciences, Torbat Heydariyeh University of Medical Sciences, Torbat Heydariyeh, Iran
[9]Student Research Committee, Torbat Heydariyeh University of Medical Sciences, Torbat Heydariyeh, Iran
[10]Health Sciences Research Center, Torbat Heydariyeh University of Medical Sciences, Torbat Heydariyeh, Iran

Corresponding Author: Mohammad Ali Mohaghegh; e-mail: Mohagheghm1@thums.ac.ir

ABSTRACT. It is estimated that one-third of the world's population is infected with *Toxoplasma gondii*. The purpose of this study was to evaluate the latest status of toxoplasmosis seroprevalence in the general population and pregnant women in the west of Iran. This retrospective cross-sectional study was conducted in 2018. Accordingly, data associated with serodiagnosis of toxoplasmosis, age, sex, anti-toxoplasmosis IgG and IgM, and pregnancy status in women were collected from 6 health centers of Kermanshah City, the west of Iran, during 2016–2017. In total, 1228 people referred to the health centers in Kermanshah City. Of 1228 people, 359 (29.23%) individuals were seropositive for toxoplasmosis, of them 294 (81.89%) individuals were seropositive only for IgG, and 65 (18.11%) individuals were both IgG and IgM seropositive. The seropositivity in men was 29.3% (n = 63), in women was 29.2% (n = 296), and in pregnant women was 25.9% (n = 44). All individuals were examined using ELISA kit. This study showed that the prevalence of this disease in the west of Iran has been decreased in comparison with the previous studies. Therefore, regular epidemiological studies of in different regions seem to be necessary in order to conclude on the decrease or increase trend of this disease in an area.

Keywords: ELISA, seroprevalence, *Toxoplasma gondii*, west of Iran

Introduction

Toxoplasmosis is a disease caused by *Toxoplasma gondii* (*T. gondii*), an obligate intracellular parasitic protozoan [1]. The members of the family Felidae are definitive host of *T. gondii* that shed oocysts in the environment [2]. The consumption of oocysts-contaminated vegetables and tissue cyst-infected meat are two main routes of human infection. Moreover, the infected lamb (tissue cyst) is the most important route of human infection worldwide but, in India, the vegetables (oocyst) has priority over lamb [3,4].

T. gondii can infect most of warm-blooded

vertebrates and is estimated that one-third of the world's population is infected with *T. gondii* [5]. The lowest seroprevalence of toxoplasmosis has been reported from several countries in the Far East, while the highest occurs in some parts of European and South American countries [6]. Toxoplasmosis may cause flu-like symptoms, however most people affected never develop signs and symptoms. Furthermore, toxoplasmosis may cause serious problems for infants born to infected mothers and people with inefficient immune systems like people with AIDS [7].

T. gondii infection in pregnant women may result in miscarriage or lifetime disabilities of the unborn child [8]. In women who become infected up to the month three, the manifestations of congenital toxoplasmosis in the neonate might contain hydrocephalus, microcephaly, retinochoroiditis, strabismus, blindness, epilepsy, psychomotor and mental retardation, and anemia [9]. Nevertheless, the infection in early pregnancy poses a low risk of fetal transmission while in the third trimester the chance of transmission is between 60% and 81%. The maternal infection in the third trimester is often asymptomatic [10].

The infection with *T. gondii* can be identified with serologic testing, amniocentesis, and the presence of abnormal ultrasound findings. Additionally, other methods have been utilized such as Western blot testing and detection of DNA with polymerase chain reaction (PCR). The serologic testing is often the first step in the analysis of toxoplasmosis using IgG and IgM antibodies. An IgG antibody testing can just be used to detect toxoplasmosis and can be also accompanied with the IgM antibody testing to differ new infection from old one [11]. However, the results of serologic tests based on IgM and IgG are often difficult to interpret and differentiate between acute and chronic infections [12,13].

The aim of this study was to evaluate the latest status of toxoplasmosis seroprevalence in the general population and pregnant women in the west of Iran.

Materials and Methods

Study design and data collection

This retrospective cross-sectional study was conducted in Kermanshah City, the west of Iran, in 2018. The data associated with serodiagnosis of toxoplasmosis were collected from 6 public health centers during 2016–2017, the west of Iran. This collected information was associated with age, sex, anti-toxoplasmosis IgG and IgM, detected by ELISA kit (Abcam, Cambridge, UK), and pregnancy status in women. All personal data remain confidential at all times.

Study area

Kermanshah Provinces is around 24,640 km^2 with a total population of about 1,952,434 people. Kermanshah Province is located between 34.3176°N and 47.0869°E. The study area is located at an average altitude of 1,330 m and an arid climate with an average annual rainfall of 516 mm. This province is one of the mountainous regions of Iran.

Data analysis

The prevalence of toxoplasmosis in women,

Table 1. The frequency of anti-*Toxoplasma gondii* IgG in all individuals

Age	Total	Positive cases	Prevalence % (95% CI[a])	P-value
< 10	194	32	16.49 (11.6–22.5)	< 0.05
11–20	133	33	24.81 (17.7–33)	
21–30	455	122	26.81 (22.8–31.1)	
31–40	343	125	36.44 (31.3–41.8)	
41–50	75	31	41.33 (30.1–53.3)	
51–60	20	11	55 (31.5–76.9)	
> 60	8	5	62.5 (24.5–91.5)	
Total	1228	359	29.23 (26.7–31.9)	

[a] Confidence interval

Table 2. The frequency of anti-*Toxoplasma gondii* IgM in all individuals

Age	Total	Positive cases	Prevalence % (95% CI[a])	P-value
< 10	194	9	4.63 (2.1–8.6)	> 0.05
11–20	133	8	6.01 (2.6–11.5)	
21–30	455	19	4.17 (2.5–6.4)	
31–40	343	22	6.41 (4.1–9.6)	
41–50	75	5	6.66 (2.2–14.9)	
51–60	20	2	10 (1.2–31.7)	
> 60	8	0	0 (0–36.9[b])	
Total	1228	65	5.29 (4.1–6.7)	

[a] Confidence interval; [b] One-sided 97.5% confidence interval

men, and pregnant women is presented as descriptive indexes. In addition, the statistical difference in the prevalence of toxoplasmosis in different age groups in men, women, and pregnant women was analyzed by Chi-square statistical test using IBM SPSS software v.16 (IBM SPSS, Armonk, NY, USA).

Ethical approval

This work was approved by the Ethical Committee of the Torbat Heydariyeh University of Medical Sciences.

Results

In total, 1228 people were referred to the health centers in Kermanshah City. Of these, 215 were men and 1013 were women, of them 170 were pregnant. Furthermore, all individuals were examined using ELISA kit (different companies). Of 1228 people, 359 (29.23%) individuals were seropositive for toxoplasmosis, of them 294 (81.89%) individuals were seropositive only for IgG, and 65 (18.11%) individuals were both IgG and IgM seropositive. In this study, no case was observed that was only IgM positive, indicating that there was no acute infection in the subjects. The

Table 3. The frequency of anti-*Toxoplasma gondii* IgG and IgM in men

Age	IgG			IgM		
	Positive cases	Prevalence % (95% CI[a])	P-value	Positive cases	Prevalence % (95% CI)	P-value
< 10	11	11 (5.6–18.8)	< 0.05	6	6 (2.2–12.6)	> 0.05
11–20	10	27 (13.8–44.1)		5	13.5 (4.5–28.8)	
21–30	11	37.9 (20.7–57.7)		2	6.9 (0.8–22.8)	
31–40	18	64.3 (44.1–81.4)		5	17.9 (6.1–36.9)	
41–50	7	58.3 (27.7–84.8)		2	16.7 (2.1–48.4)	
51–60	4	57.1(18.4–90.1)		1	14.3 (0.4–57.9)	
> 60	2	100 (15.8[b]–100)		0	0 (0–84.2[b])	
Total	63	29.3 (23.3–35.9)		21	9.8 (6.1–14.5)	

[a] Confidence interval; [b] One-sided 97.5% confidence interval

Table 4. The frequency of anti-*Toxoplasma gondii* IgG and IgM in women[a]

Age	IgG			IgM		
	Positive cases	Prevalence % (95% CI[b])	P-value	Positive cases	Prevalence % (95% CI)	P-value
< 10	21	22.3 (14.4–32.1)	> 0.05	3	3.2 (0.7–9)	> 0.05
11–20	23	24 (15.8–33.7)		3	3.1 (0.6–8.9)	
21–30	111	26.1 (21.9–30.5)		17	4 (2.3–6.3)	
31–40	107	34 (28.8–39.5)		17	5.4 (3.2–8.5)	
41–50	24	38.1 (26.1–51.2)		3	4.8 (1–13.3)	
51–60	7	53.8 (25.1–80.8)		1	7.7 (0.2–36)	
> 60	3	50 (11.8–88.2)		0	0 (0–45.9[c])	
Total	296	29.2 (26.4–32.1)		44	4.3 (3.2–5.8)	

[a] All women, including pregnant women, was considered; [b] Confidence interval; [c] One-sided 97.5% confidence interval

prevalence of anti-toxoplasmosis IgG and IgM in all individuals is presented in Table 1 and Table 2, respectively.

Of 215 men, 42 (19.53%) were seropositive only for IgG and 21 (9.76%) were seropositive both for IgG and IgM. Totally, seropositivity in men was 29.3% (n = 63). The prevalence of toxoplasmosis in the men's population is presented in Table 3.

Of 1013 women, 252 (85.13%) were seropositive only for IgG and 44 (14.86%) were seropositive both for IgG and IgM. Totally, seropositivity in women was 29.2% (n = 296). The prevalence of toxoplasmosis in the women's population is presented in Table 4.

Of 170 pregnant women, 41 (24.11%) were seropositive only for IgG and 3 (6.81%) were seropositive both for IgG and IgM. Totally, seropositivity in pregnant women was 25.9% (n = 44). The prevalence of toxoplasmosis in the pregnant women's population is shown in Table 5.

In addition, data analysis showed that the odds ratio of the toxoplasmosis prevalence in women and men was equal (Table 6).

Discussion

Prevalence of toxoplasmosis varies from one country to another or even from area to area within

Table 5. The frequency of anti-*Toxoplasma gondii* IgG and IgM in pregnant women

Age	IgG			IgM		
	Positive cases	Prevalence % (95% CI[a])	P-value	Positive cases	Prevalence % (95% CI)	P-value
11–20	5	27.8 (9.7–53.5)	> 0.05	0	0 (0–18.5[b])	> 0.05
21–30	14	18.4 (10.5–29)		1	1.3 (0–7.1)	
31–40	17	28.8 (17.8–42.1)		2	3.4 (0.4–11.7)	
41–50	7	46.7 (21.3–73.4)		0	0 (0–21.8[b])	
51–60	1	50 (1.3–98.7)		0	0 (0–84.2[b])	
Total	44	25.9 (19.5–33.1)		3	1.8 (0.4–5.1)	

[a] Confidence interval; [b] One-sided 97.5% confidence interval

Table 6. The odds ratio of the toxoplasmosis prevalence in women and men

	No. (%) of seropositive	No. (%) of seronegative	Odds ratio (OR)	95% CI Lower – Upper	P-value
Male	63 (29.3)	152 (70.7)			
Female	296 (29.2)	717 (70.8)	1.004	0.727–1.387	0.98

a country, ranging from less than 10% in some areas of the northern Europe to more than 90% in Africa [14].

The findings of the present study showed that the toxoplasmosis prevalence was 29.23% (n = 359) in all individuals, 29.3% (n = 63) in men, 29.2% (n = 296) in women, and 25.9% (n = 44) in pregnant women in the west of Iran. As compared to the results of the present study, the previous study conducted by Athari et al. [15] on pregnant women in Kermanshah City showed that 32.7% (n = 495) of pregnant women were seropositive for toxoplasmosis. Another study in Kermanshah City revealed that 36.4% (n = 1837) of subjects were seropositive for anti-toxoplasmosis IgG. Furthermore, the seropositivity rate in men was 32.2% (n = 761) and in women was 39.3% (n = 1076). In addition, the highest infected age group was 30–39 years [16]. Given the aforementioned issues, it seems that the toxoplasmosis prevalence is decreasing in the west of Iran during the last three decades. In addition, the authors in the recent study showed that the seropositivity in women was somewhat higher than that of men, while in our study, the odds ratio of infection was equal for men and women (Table 6).

In non-mountainous provinces with low rainfall, the incidence of toxoplasmosis is reported to be 25–29.6% [17–19]. In mountainous provinces with high rainfall, this rate is reported to be 34.2–37.9% [20,21]. In the present study, the total seroprevalence of toxoplasmosis was 29.23% which was somewhat different from what has been reported form mountainous provinces.

In order to screen individuals in terms of toxoplasmosis, serologic tests are carried out based on IgG and IgM [22]. In some cases, the level of IgM remains high for several months or years that in such cases the IgG avidity test should be performed to distinguish between new and old infection [23]. The latter test is not usually carried out in health centers. Therefore, screening of individuals serologically based on IgG and IgM does not give us an absolute result as to what should be exerted about them? Diagnosis using PCR method on maternal samples in Austria and France has been resulted in early treatment and considerably decreased hydrocephalus cases in neonates (i.e. 0.5% in France vs. 31% in the US) [24]. Thus, it is better to consider diagnostic approach in health centers based on PCR method. The researchers in the latter study stated that the chance of infection in men was 1.76-times higher than that of women. In addition, according to the report of a study in the US, the seropositivity in men was higher than that of women. However, in our study the chance of being infected with *T. gondii* was equal between men and women (OR = 1.004; P = 0.98).

A retrospective study performed in Paris, France, on individual samples from 1997 to 2014 showed that the seroprevalence of toxoplasmosis has continuously decreased over time. The highest annual decrease rate of infection was associated with the age group < 20 years with 5% decrease per year [25].

In China, the seroprevalence of toxoplasmosis in pregnant women from 2000 to 2016 was 2.1% to 11% in various areas [8]. Moreover, in Sri Lanka from 2010 to 2013, seropositivity in pregnant women based on IgG was 29.9% and based on IgM was 0.37% [26]. The amount of anti-*Toxoplasma* IgG in sera of pregnant women in Morocco was 28.8% [27] which was close to the result of the current study. The results of a study in Hermosillo city, Mexico, on blood donors showed that the seroprevalence of anti-*Toxoplasma* IgG was 13.5% and this value for IgM was 21.8% [28]. According to the results of a study, the seroprevalence of toxoplasmosis among childbearing women in the west of Romania was 51.89% and anti-toxoplasmosis IgG was detected in 50.99% of women of childbearing age and IgM in 0.9% of them [29]. In the current study, the seropositivity in pregnant women for IgG was 25.9% (n = 44) and for IgM was 1.8% (n = 3).

A study on the Indian population in Brazil showed that the seroprevalence of toxoplasmosis was 73.5% and there was a direct relationship between age and seroprevalence of toxoplasmosis

[30]. Likewise, in the current study, as the age increased, seropositivity also increased so that the highest seropositivity was observed at the age group > 60 years.

There are particular risk factors in relation to the prevalence of toxoplasmosis including age, interaction with cats, daily contact with soil, humidity, keeping pets at home, eating raw or uncooked vegetables, eating raw or uncooked meat, of which the most important risk factors are the last two ones [31,32]. Unfortunately, due to lack of information we could not provide risk factors in this article.

Several factors apart from topographical features might account for seroprevalence variances in different areas, including the demographic characteristics, sensitivity and specificity of the tests, and socioeconomic status of populations [33]. Serological screening programs during pregnancy are essential for the detection of new toxoplasmosis infection and early treatment initiation; however, different serological procedures for serodiagnosis of toxoplasmosis have dissimilar specificity and sensitivity, so that sometimes the two methods even in the same laboratory show different results [34]. As a consequence, improved diagnostic methods, such as detection of toxoplasma DNA by PCR method in amniotic fluid samples of pregnant women makes it possible to timely identify the infected fetus with toxoplasmosis during pregnancy [35]. Recently introduced non-invasive diagnostic method based on the detection of free DNA of *T. gondii* in the body's fluid such as urine and saliva is appreciated, especially in immunocompromised patients who are unable to produce antibodies so much as to be recognizable [36]. In general, according to various published articles about seroprevalence of toxoplasmosis, it seems that the spread of the disease in different regions is decreasing, which is probably due to the increased awareness of people about the disease. In this study, the prevalence of this disease in the west of Iran has been decreased during the last three decades in comparison with the previous studies. In addition to raising awareness about these diseases among the public in this area, the main reasons for the decrease of prevalence are most likely greenhouse vegetables production, industrial livestock farming, and the reduction of rainfall during several consecutive years. Therefore, regular epidemiological studies of the disease in different regions seem to be necessary in order to conclude more precisely about the risk factors associated with this disease and its tendency to be decreased or increased in an area.

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