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Seroepidemiological Survey of Toxoplasmosis Among Pregnant and Abortive Women of Gonabad

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Abstract

Objectives: Maternal immunity to *Toxoplasma gondii* is critical during pregnancy. Non-immunized women may be at the risk of toxoplasmosis during pregnancy. This parasite can pass through the placenta to the fetus and causes severe complications in the fetus. This study aimed to investigate the seroepidemiology of *Toxoplasma* infection in pregnant women of Gonabad.

Materials and Methods: Three hundred blood samples were collected from pregnant women and abortive women of 18-40 years old who referred to the health centers and hospitals of Gonabad. The immunoglobulin G (IgG) and immunoglobulin M (IgM) antibody titers were measured by the enzyme-linked immunosorbent assay.

Results: The samples were taken from 252 (84.0%) pregnant women and 48 (16.0%) women with abortion. The average age of these women was 29.23 ± 6.24 years. Among these subjects, 56 (22.2%) pregnant women and 15 (31.3%) women with a history of abortion had anti-Toxoplasma IgG antibodies while 196 (77.8%) pregnant women and 33 (68.7%) women with abortion history did not have this specific antibody. Based on the results, 3 (1.2%) pregnant women had IgM antibodies while this antibody was not observed in any woman with a history of abortion. Finally, the prevalence of toxoplasmosis was 23.6%.

Conclusions: According to the results, 76.33% of pregnant and abortive women in Gonabad have no history of *Toxoplasma* infection. Therefore, they are prone to toxoplasmosis infection during their pregnancies. In this regard, it is necessary to establish public health and preventive actions, as well as a rapid diagnosis to eliminate risk factors during pregnancy.

Keywords: Seroepidemiology, *Toxoplasma* infection, Abortive women, Pregnant women

Introduction

Toxoplasma is a common parasite and capable of replication in many vertebrate hosts. However, its definitive host includes domesticated cats and some other Feliformia. The parasite was first identified and named as "*Ctenodactylus gundi*" in a rodent in North Africa. Although only domesticated cats or some wild species can produce oocytes, a wide range of animals, including sheep, cows, and pigs can be infected by eating oocytes. These animals carry infectious cysts in their muscular tissues. Parasites can survive for many years in the cysts. In addition, humans may be infected by eating stuff infected with infectious cat feces and raw or rare meats of cows, pigs, or sheep, which contain *Toxoplasma* cyst (1).

Contamination with these protozoa usually has no clinical symptoms in people with a healthy immune system. However, chorioretinitis, lymphadenitis, or myocarditis may occasionally occur after the initial infection. Thus, it is essential to prevent pregnant women with a negative serum test (seronegative) and immunocompromised patients from this infection. The preventive measures of *Toxoplasma* infection for such people include preventing the ingestion of contaminated cysts and contact with the defecated oocytes of cats (2). It is estimated that more than 500 million people worldwide are infected with this parasite (3). It can infect human beings by either acquired or congenital ways. The acquired *Toxoplasma* infection is due to the consumption of raw or rare meat or water, vegetables, and fruit contaminated with parasite oocytes. Blood transfusions, organ transplantation, or rarely accidental inoculation in laboratory events may also lead to acquired *Toxoplasma* infection (4). Humans' *Toxoplasma* infection consists of two acute and chronic stages while most symptoms and complications, and the transmission of parasites from the mother to the fetus occur in the acute phase of infection (5). One of the most crucial transmission ways of this parasite happens through the placenta, and 5 out of 1000 seronegative women infected with *Toxoplasma gondii* pass on the parasite to their fetus during pregnancy (6).

Congenital toxoplasmosis generally occurs when the mother is first infected with *Toxoplasma* during pregnancy. In other words, *Toxoplasma* infection does not threaten the fetuses in the women, who have been

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infected with *Toxoplasma* before the pregnancy, only if the immune system would function adequately. The transmission rate of toxoplasmosis during the first, second, and third trimesters is 10%-25%, 30%-45%, and 60%-65%, respectively. Further, congenital toxoplasmosis has different clinical manifestations while clinical signs vary depending on which period of pregnancy the infection is transmitted to the fetus. Furthermore, congenital *Toxoplasma* symptoms include hydrocephalus, chorioretinitis encephalomyelitis, stillbirth, spleen and liver enlargement, mental and motor disorders, seizure, and visual impairment or blindness while the most common ones are chorioretinitis and central nervous system lesions (7).

Consequently, congenital toxoplasmosis is medically essential, and women's awareness of this disease and ways of its transmission can significantly reduce its incidence. The prevalence of humans' *T. gondii* infection is varying in different regions relying on age, the geographical location of the region, temperature, humidity (3,8), and food habits (5,9), and whether they keep cats as a pet or not. Moreover, older ages, more consumption of rare or raw meat, keeping the cat at home, and living in warm, humid, and low altitude areas are associated with a higher incidence of this disease (7). Serological research showed that the prevalence of this parasite in different parts of the world and among different population groups is between 0% and 95% (10). Additionally, Salahi-Moghaddam and Hafizi demonstrated that the prevalence of this parasite was 68.4% in the human community of southern Tehran (11). Evidence indicates that around 75% of women in the world are serologically negative for *Toxoplasma*. Therefore, they are at the risk of transmitting the congenital toxoplasmosis. Similarly, the incidence of acquired contamination depends on the contamination risk of the area and the amount of not previously infected population. Hence, obtaining information is essential in each region in favor of reducing the rate of *Toxoplasma* infection. There were widespread investigations on the prevalence of *Toxoplasma* in Iran while all indicating a high prevalence in different parts of the country. The prevalence of toxoplasmosis in the cold and mountainous regions of the northwest and center of Iran is 18%-38% and 33%-68% in the warm and dry regions of western Iran. In addition, it is about 39% and 20-35% in the warm and dry regions, as well as warm and humid areas of southern Iran (8). A study in Khorramabad showed that 31% of pregnant women had anti-*T. gondii* antibodies (12). In another study done in Tabriz, 26.3% and 0.33% of women had IgG and IgM antibodies, respectively (13). Based on the results of a study in Alborz province, 64% and 1.7% of pregnant women had IgG and IgM antibodies, respectively (14).

Considering the importance of *Toxoplasma* infection transmission and its complications during pregnancy and the lack of enough studies on the prevalence of this infection among pregnant women in Iran, it seems necessary to investigate the prevalence of its infection. Accordingly, the aim of this study was to determine the seroprevalence of *Toxoplasma* infection in pregnant population in the east region of Iran, followed by investigating the effects of several variables such as age (whether they keep a cat as pet or not), raw or rare meat consumption, education, and the place of residence on *Toxoplasma* infection.

Materials and Methods

Using a descriptive-analytic approach with the easy sampling method, this cross-sectional study was conducted on 300 pregnant women with abortion who referred to the clinics and health centers of Gonabad in 2017. The data collection tool was a questionnaire based on demographic characteristics while risk factors for this disease including abortion history, habitat status, the use of grilled meat and raw vegetables, and keeping a cat at home were completed by the questionnaire upon the satisfaction of the research units. After completing the questionnaire, 5 mL of blood was taken from each participant for the tests. The blood samples were collected in the clotting tubes and then centrifuged for 10 minutes at 2500 rpm, followed by isolating and maintaining their serums at -20°C until performing the test. After completing the sampling, the samples were taken to measure IgG and IgM anti-*Toxoplasma* antibodies with the enzyme-linked immunosorbent assay (ELISA) Kit (Pishtaz Teb Company) according to kit instructions using the ELISA reader (stat fax 4500). The optical density value of the wells at a wavelength of 450 nm was measured to be 630 using a reference filter. In the ELISA, the patient's serum was added to the wells covered with pure toxoplasmic antigens, and the color intensity was measured after incubation, washing, the addition of conjugate enzyme-containing anti-human globulin, and eventually chromogen. According to the kit instruction for IgG antibodies in a healthy population, the cut-off value of 10 IU/mL is equivalent to the standard, and the values lower and higher ten are negative and positive, respectively. People with an IgG antibody level between 9 and 11 were considered as suspect cases. For IgM antibodies, values greater than 1.1, lower than 0.9, and within the range of 0.9-1.1 were considered as positive, negative, and a suspect, respectively. Sampling was repeated in all suspicious cases after a while. Finally, the data were analyzed using SPSS software, version 21 and descriptive statistics, and a P value less than 0.05 was considered to be statistically significant.

Results

In this study, the samples were taken from 252 (84.0%) pregnant women and 48 (16.0%) women with abortion. The mean age was 29.23 ± 6.24 years. Among these subjects, 56 (22.2%) pregnant women and 15 (31.3%) women with abortion history had anti-*Toxoplasma* IgG

antibodies while 196 (77.8%) pregnant women and 33 (68.7%) women with abortion history did not have this specific antibody. Based on the results, 3 (1.2%) pregnant women had IgM antibodies although this antibody was not found in any women with a history of abortion. The prevalence of toxoplasmosis was 23.6%. Moreover, 68 (77.3%) subjects had chronic infections of toxoplasmosis (IgG+ and IgM-) and 3 (1.0%) subjects had acute or sub-acute toxoplasmosis infections (IgG and IgM+). The highest prevalence of anti-*Toxoplasma* IgG antibodies was observed in the age group of 25-35 years old with a prevalence of 60.5%. Furthermore, the highest prevalence of anti-*Toxoplasma* IgM antibodies was found in the age group of 35-35 years old, with a prevalence of (66.6%). Moreover, the prevalence of anti-*Toxoplasma* IgG antibodies in pregnant women with a university education and women with high school education was 37.5% (21 cases) and 40% (6 cases), respectively. According to Table 1, the results of the Chi-square test showed that there is no significant relationship between IgG and the location variables such as habitat, education level, the consumption of grilled meat, and raw vegetables ($P<0.05$). Conversely, the results of this test indicated that there is a significant relationship between IgG and the history of contact with cats ($\chi^2= 4.1$, P value = 0.043), the related data are shown in Figures 1, 2, and 3. However, no significant relationship was observed between IgG and educational variables, contact with cats, and the consumption of grilled meat and raw vegetables in women with a history of abortion. On the other hand, a significant relationship was found between IgG and residence (P = 0.005) because the IgG antibody was observed to be more prevalent in rural women. The results of the chi-square test demonstrated that there was no significant relationship between IgM and age, residence, education level, and the consumption of grilled meat and raw vegetables in pregnant women. Contrarily, a significant relationship was detected between IgM and the history of contact with cats (P = 0.01). Based on the data in Table 2, the results of the chi-square test revealed no significant relationship between the presence of IgG and the location variables, occupation, educational level, barbecue consumption, and the use of raw vegetables. However,

Table 1. Relationship Between IgG and the Studied Variables Among Pregnant and Abortive Women

Variables		Aborted Women				Pregnant Women			
		IgG Positive Cases (%)	IgG Negative Cases (%)	Total	*P*-value	IgG Positive Cases (%)	IgG Negative Cases (%)	Total	*P*-value
Age (y)	<25	3 (17.6)	14 (82.4)	17 (35.4)	F=4.48 *P*=0.124	10 (13.3)	65 (86.7)	75 (29.8)	Chi=4.94 *P*=0.08
	25 to 35	9 (50.0)	9 (50.0)	18 (37.5)		34 (25.6)	99 (74.4)	133 (52.8)	
	>35	3 (23.1)	10 (76.9)	13 (27.1)		12 (27.3)	32 (72.7)	44 (17.5)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
Place of residence	Rural	3 (12.5)	21 (87.5)	24 (50.0)	Chi=7.86 *P*=0.005	36 (22.5)	124 (77.5)	160 (63.5)	Chi=0.02 *P*=0.889
	Urban	12 (50.0)	12 (50.0)	24 (50.0)		20 (21.7)	72 (78.3)	92 (36.5)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
Occupation	Housewives	11 (28.2)	28 (71.8)	39 (81.3)	F=2.195 *P*=0.366	47 (24.2)	147 (75.8)	194 (77.0)	Chi=5.01 *P*=0.08
	Employee	1 (25.0)	3 (75.0)	4 (8.3)		8 (23.5)	26 (76.5)	34 (13.5)	
	Self-employment and students	3 (60.0)	2 (40.0)	5 (10.4)		1 (4.2)	23 (95.8)	24 (9.5)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
Educational level	Elementary and lower	5 (41.7)	7 (58.3)	12 (25.0)	F=0.89 *P*=0.722	19 (28.8)	47 (71.2)	66 (26.2)	Chi=3.14 *P*=0.208
	High school	6 (27.3)	16 (72.7)	22 (45.8)		16 (17.0)	78 (83.0)	94 (37.3)	
	University education	4 (28.6)	10 (71.4)	14 (29.2)		21 (22.8)	71 (77.2)	92 (36.5)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
History of close contact with cats	Yes	7 (38.9)	11 (61.1)	18 (37.5)	Chi=0.78 *P*=0.376	18 (32.1)	38 (67.9)	56 (22.2)	Chi=4.1 *P*=0.043
	No	8 (26.7)	22 (73.3)	30 (62.5)		38 (19.4)	158 (80.6)	196 (77.8)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
Exceed consumption of grilled or raw meats	Yes	2 (22.2)	7 (77.8)	9 (18.8)	Chi=0.42 *P*=0.517	11 (24.4)	34 (75.6)	45 (17.9)	Chi=0.157 *P*=0.692
	No	13 (33.3)	26 (66.7)	39 (81.2)		45 (21.7)	162 (78.3)	207 (82.1)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	
Use of disinfectant for washing vegetables	Yes	13 (31.7)	28 (63.3)	41 (85.4)	Chi=0.027 *P*=0.869	53 (23.7)	171 (76.3)	224 (88.9)	Chi=2.41 *P*=0.12
	No	2 (28.6)	5 (71.4)	7 (14.6)		3 (10.7)	25 (89.3)	28 (11.1)	
Total		15 (31.2)	33 (68.8)	48 (100.0)		56 (22.2)	196 (77.8)	252 (100.0)	

Note. IgG: Immunoglobulin G.

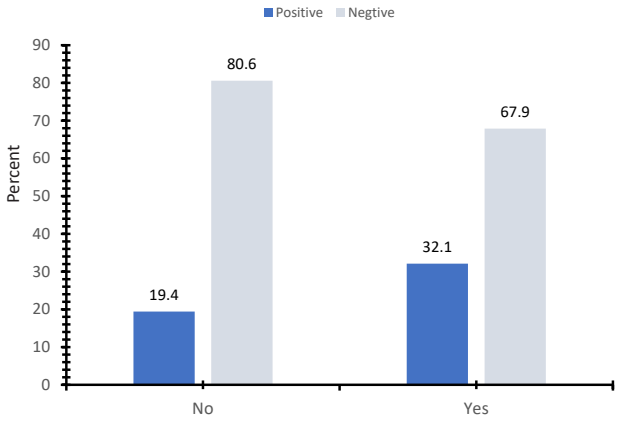

Figure 1. Relationship between exposure to cats and immunoglobulin G in pregnant women.

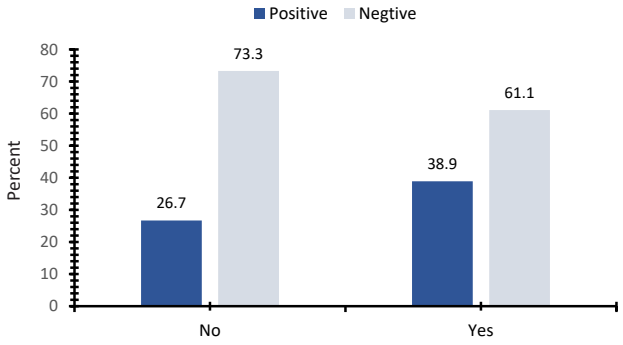

Figure 2. Relationship between exposure to cats and immunoglobulin G in abortion women.

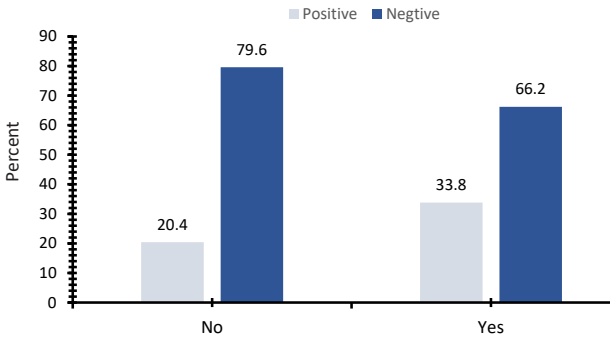

Figure 3. Relationship between exposure to cats and immunoglobulin G in all subjects.

the results of this test showed that there is a significant relationship between IgG and the history of contact with cats ($\chi^2 = 5.57$, $P = 0.018$), the data of which are depicted in Figures 4 and 5. In contrast, no significant relationship was found between IgM and location variables, barbecue, and raw vegetable consumption. On the other hand, the results indicated a significant relationship between the presence of IgM and both the history of contact with a cat ($P = 0.01$) and occupation ($P = 0.01$) as the IgM antibody was observed to be more common among the employees. Additionally, the Spearman correlation coefficient test showed that there is a significant positive correlation between age and IgG titer (r = 0.120) ($P = 0.038$) while showing no significant correlation between IgM and age (r = 0.048, $P = 0.408$). In addition, the results represented no significant relationship between the week of pregnancy and the IgG results ($P = 0.73$).

However, a significant relationship was observed between the week of pregnancy and IgM results ($P = 0.049$). Based on the results of the Mann-Whitney test, there was no significant relationship between IgG titers and variables including location variables, barbecue consumption, history of contact with cats, consumption of raw vegetables, and other infectious diseases. However, the Kruskal-Wallis test demonstrated a significant correlation between IgG titer and education level ($\chi^2 = 8.11$, $P = 0.044$). The results further indicated that the level of antibody was higher in pregnant women with elementary education or less than those with average and university education levels. Based on the findings, there was no significant correlation between IgG and occupation ($\chi^2 = 1.83$, $P = 0.767$). Furthermore, the results of the Mann-Whitney test showed no significant correlation between IgM titers and variables including location variables, the consumption of barbecue and raw vegetables, the history of contact with cats, and other infectious diseases. Finally, the Kruskal-Wallis test indicated that there was no significant relationship between IgM titers and variables including the level of education and occupation.

Discussion

The prevalence of *Toxoplasma* antibodies in the world has been reported to be 0.97% to 84% (15) while acute toxoplasmosis has been reported in 1 to 8 out of 1000 pregnancies (16). The prevalence of congenital toxoplasmosis in Europe, North America, South America, Africa, and Southeast Asia has been reported to be 5, 6, 18-34, 20-24, and 18-34 persons in 10 000 pregnancies, respectively (17). Moreover, the prevalence of *Toxoplasma* antibodies in Kuwait, South America, Iraq, Spain, and Poland was reported to be 13.8% (18), 2.8% (19), 0.97% (20), 0.01% (21), and 0.5% (22), respectively. In this study, the samples were taken from 252 (84%) pregnant women and 48 (16%) women with a history of abortion. Anti-*Toxoplasma* IgG antibodies were detected in 22.2% and 31.3% of pregnant women and women with a history of abortion, respectively. On the other hand, 77.8%, 68.7% of pregnant women and women with a history of abortion had no specific antibodies. The prevalence of antibodies in pregnant women of Mashhad was reported to be 34.4% (23), which indicated that this city in the northern Khorasan Razavi province has a milder air and its annual rainfall is higher than Gonabad, which is located in the south of Khorasan Razavi and has desert weather. Therefore, the environment of Mashhad is more suitable

Table 2. Relationship Between the Presence of IgM and IgG and the Studied Variables in the Subjects

Variables		IgM				IgG			
		Positive cases (%)	Negative cases (%)	Total	*P*-value	Positive cases (%)	Negative cases (%)	Total	*P*-value
Age (y)	<25	0 (0.0)	92 (100.0)	92 (30.7)	F=1.54 *P*=0.59	13 (14.1)	79 (85.9)	92 (30.7)	Chi=6.79 *P*=0.034
	25 to 35	2 (1.3)	149 (98.7)	151 (50.3)		43 (28.5)	108 (71.5)	151 (50.3)	
	>35	1 (1.8)	56 (98.2)	57 (19.0)		15 (26.3)	42 (73.7)	57 (19.0)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
Place of residence	Rural	3 (1.6)	181 (98.4)	184 (61.3)	*P*=0.286	39 (21.2)	145 (78.8)	184 (61.3)	Chi=1.61 *P*=0.205
	Urban	0 (0.0)	116 (100.0)	116 (38.7)		32 (27.6)	84 (72.4)	116 (38.7)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
Occupation	Housewives	0 (0.0)	233 (100.0)	233 (77.7)	F=9.57 *P*=0.011	58 (24.9)	175 (75.1)	233 (77.7)	Chi=1.76 *P*=0.415
	Employee	2 (5.3)	36 (94.7)	38 (12.7)		9 (23.7)	29 (76.3)	38 (12.7)	
	Self-employment and students	1 (3.4)	28 (96.6)	29 (9.7)		4 (13.8)	25 (86.2)	29 (9.7)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
Educational level	Illiterate	0 (0.0)	6 (100.0)	6 (2.0)	Chi = 8.11 *P* = 0.044	3 (50.0)	3 (50.0)	6 (2.0)	Chi=4.93 *P*=0.18
	Elementary and lower	0 (0.0)	72 (100.0)	72 (24.0)		21 (29.2)	51 (70.8)	72 (24.0)	
	High school	0 (0.0)	116 (100.0)	116 (38.7)		22 (19.0)	94 (81.0)	116 (38.7)	
	University Education	3 (2.8)	103 (97.2)	106 (35.3)		25 (23.6)	81 (76.4)	106 (35.3)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
History of close contact with cats	Yes	3 (4.1)	71 (95.9)	74 (24.7)	*P*=0.015	25 (33.8)	49 (66.2)	74 (24.7)	Chi=5.57 *P*=0.018
	No	0 (0.0)	226 (100.0)	226 (75.3)		46 (20.4)	180 (79.6)	226 (75.3)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
Exceed consumption of grilled or raw meats	Yes	1 (1.9)	53 (98.1)	54 (18.0)	Chi=0.49 *P*=0.487	13 (24.1)	41 (75.9)	54 (18.0)	Chi=0.006 *P*=0.938
	No	2 (0.8)	244 (99.2)	246 (82.0)		58 (23.6)	188 (76.4)	246 (82.0)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	
Use of disinfectant for washing vegetables	Yes	3 (1.1)	262 (98.9)	265 (88.3)	*P*>0.999	66 (24.9)	199 (75.1)	265 (88.3)	Chi=1.93 *P*=0.165
	No	0 (0.0)	35 (100.0)	35 (11.7)		5 (14.3)	30 (85.7)	35 (11.7)	
Total		3 (1.0)	297 (99.0)	300 (100.0)		71 (23.7)	229 (76.3)	300 (100.0)	

Note. IgM: Immunoglobulin M; IgG: Immunoglobulin G.

for oocytes to mature, and consequently, *Toxoplasma* has a higher prevalence in Mashhad compared to Gonabad. The prevalence of *Toxoplasma* parasites was found to be 41% in Iranian pregnant women (24). In a study, the prevalence of *Toxoplasma* parasites in pregnant women of Golestan, Zahedan, Yazd, Urmia, the North Khorasan, and Ilam was reported to be 35.2% (25), 49.8% (26), 32% (27), 18.4% (15), 42.3% (28), and 44.6% (29), respectively. In Khuzestan province, the prevalence of antibodies in pregnant women was 27.3% (30), which is consistent with the result of the present study. This indicates that in areas such as Khuzestan and Gonabad with less annual rainfall, the prevalence of antibodies against this parasite is also low and the environment is unsuitable for oocyte maturation. In this study, 1.2% of pregnant women had IgM antibodies while the antibody was not detected in women with a history of abortion. In the study conducted in Urmia and Zanjan, the prevalence of this antibody was reported to be 1.4%, which is in line with the results of the present study (31,32). In another study, the prevalence of IgM antibodies in pregnant women in Minab, Golestan province, the North Khorasan province, Gorgan, the Fars province, and the west of Iran was reported to be 2.5% (33), 5.7% (25), 3.42% (28), 3.4% (34), 0.02% (35), and 5.7% (36), respectively. In the present study, 1% of the subjects had IgG antibodies in addition to IgG. In Minab, 1% of pregnant women had IgG and IgM antibodies (12), which corroborates the results of this study. In Golestan and Gorgan, 2% and 1.4% of pregnant women had both IgG and IgM antibodies, respectively (25). In

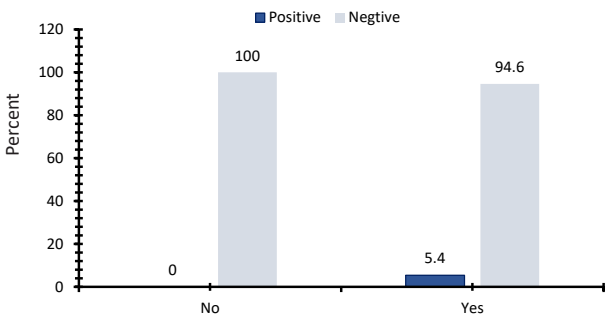

Figure 4. Relationship Between Exposure to Cats and Immunoglobulin M in Pregnant Women.

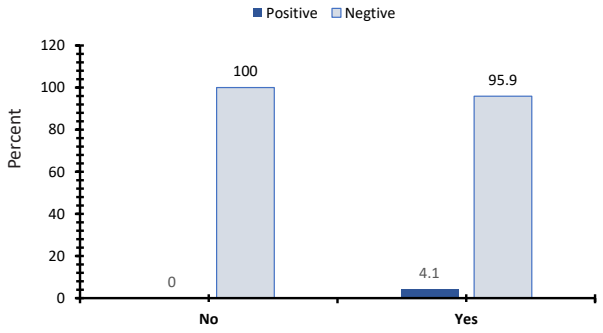

Figure 5. Relationship between exposure to cats and immunoglobulin m in all subjects.

Khoramabad and Fars provinces, 7.4% and 0.02% of pregnant women had both antibodies, respectively (12, 35) while the difference in the results of these two regions may be due to the different climate of these regions. In this study, there was no significant relationship between IgG and the place of residence, educational level in addition to the consumption of grilled meat and raw vegetables ($P > 0.05$). However, there was a significant relationship between IgG and cat contact history ($P = 0.043$). In a study in the Golestan province, there was no significant relationship between IgG and the place of residence, education level, the consumption of grilled meat and raw vegetables, and contact with cats (25). In another study in Yazd on pregnant women, no significant correlation was found between IgG and variables, including contact with cats, the consumption of grilled meat, and the method of washing vegetables (27). In Minab, no significant relationship was observed between IgG levels and variables including education level and residence whereas there was a significant relationship between the age and the presence of this antibody (33). In Mashhad, there was no significant relationship between IgG and variables, including contact with cats and the consumption of grilled meat while a significant relationship was detected between IgG and the place of residence (23). In this study, there was no significant correlation between the presence of IgG antibodies and variables including the level of education, the consumption of grilled meat, the method of washing vegetables, and contact with cats. However, there was a significant relationship between IgG and the place of residence.

Moreover, the prevalence of antibodies was higher in villages ($P = 0.005$). IgG antibody levels were also higher in rural women in studies conducted in Golestan, Minab, and Nikshahr (25,33,37). One of the strengths of this study was that the relationship between IgG and risk factors was also evaluated in women with a history of abortion. In our study, there was a positive correlation between age and IgG titers ($P = 0.038$) although there was no significant correlation between age and IgM titers ($P = 0.408$). However, there was no significant relationship between age and IgG titers in studies conducted in Urmia and Yazd (15, 27). In Gorgan, it was found that there was a significant relationship between age and infection with *Toxoplasma* parasites (34). In Minab, it was also shown that IgG antibody titers increase with age (33). Conversely, no significant correlation was found between age and anti-*Toxoplasma* antibody titer in Golestan (25). However, there was a significant relationship between age and IgG titer in the North Khorasan, but there was no significant correlation for IgM titer (28), which is consistent with the results of our study. In this study, it was shown that the lower level of education leads to a higher IgG antibody titer. The results of the research on the relationship between education level and IgG antibodies in Minab (33), Kermanshah (38), and Yazd (27) are similar to those of the present study. Our results showed that there was no significant relationship between IgM and variables, including age, the place of residence, education level, as well as the consumption of grilled meat and raw vegetables. However, a significant relationship was observed between IgM and variables, including contact with cat and occupation ($P = 0.01$). In Lorestan and the North Khorasan, a significant relationship was reported between IgM and the contact with cats in pregnant women (28, 39). In our study, no significant relationship was found between a gestational week and IgG ($P = 0.73$). However, there was a significant relationship between a gestational week and IgM ($P = 0.049$). In the study conducted in Khoramabad and the North Khorasan, the results demonstrated a significant relationship between IgM and gestational week (12), which is consistent with the findings of our study.

Conclusions

Health education regarding avoiding having contact with cats or keeping them at home, as well as avoiding using raw or rare meats or even unreliable water for drinking is necessary for preventing the transmission of *Toxoplasma*. Eventually, antibody titer tests before and after marriage

and pregnancy are crucial for reducing the probable complications of the disease.

Conflict of Interests
The authors declare that they have no conflict of interests.

Ethical Issues
This study was approved by the Research Council and the Ethics Committee of Gonabad University of Medical Sciences (Ir.gmu.rec.1396.27).

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References
1. Abdoli A, Dalimi A, Arbabi M, Ghaffarifar F. Neuropsychiatric manifestations of latent toxoplasmosis on mothers and their offspring. J Matern Fetal Neonatal Med. 2014;27(13):1368-1374. doi:10.3109/14767058.2013.858685
2. Sabi E. Textbook of Clinical Parasitology, Protozoal Dis eases in Iran. Tehran: Hayyan Co; 1998:247-298. [Persian].
3. Flegr J. Influence of latent Toxoplasma infection on human personality, physiology and morphology: pros and cons of the *Toxoplasma*-human model in studying the manipulation hypothesis. J Exp Biol. 2013;216(Pt 1):127-133. doi:10.1242/jeb.073635
4. Zare F, Dalimi Asl A, Ghaffarifar F. Detection of active *Toxoplasma gondii* (RH strain) in the different body tissues of experimentally infected rats. Pathobiology Research. 2010;9:19-23.
5. Bennett JE, Dolin R, Blaser MJ. Principles and Practice of Infectious Diseases. Elsevier Health Sciences; 2014.
6. Desmonts G, Couvreur J. Congenital toxoplasmosis. A prospective study of 378 pregnancies. N Engl J Med. 1974;290(20):1110-1116. doi:10.1056/nejm197405162902003
7. Garcia LS, Bruckner DA. Diagnostic Medical Parasitology. Washington, DC: ASM Press; 2001:131-135.
8. Khan K, Khan W. Congenital toxoplasmosis: an overview of the neurological and ocular manifestations. Parasitol Int. 2018;67(6):715-21.
9. Athari A, Shojaeian S, Eliasi O, Delfani K. Seroprevalence of *Toxoplasma* antibodies among pregnant women in Kerman Shah. Med J Islam Repub Iran. 1994;8(2):93-95.
10. Boothroyd JC. *Toxoplasma gondii*: 25 years and 25 major advances for the field. Int J Parasitol. 2009;39(8):935-946. doi:10.1016/j.ijpara.2009.02.003
11. Salahi-Moghaddam A, Hafizi A. A serological study on *Toxoplasma gondii* infection among people in south of Tehran, Iran. Korean J Parasitol. 2009;47(1):61-63. doi:10.3347/kjp.2009.47.1.61
12. Cheraghi pour K TH fM, Maghsiud A. The prevalence of IgM and IgG anti-*Toxoplasm*a antibodies in pregnant women referring to health care centers in Khorramabad. J Clinl Med. 2010;7(3):46-51.
13. Dalimiasl a, Arshad M. Sero-epidemiology of *Toxoplasma* infection in pregnant women referred to Al Zahra hospital in Tabriz. Journal of Ilam University of Medical Sciences. 2012;20(3):55-62. [Persian].
14. Akhlaghi L, Ghasemi A, Hadighi R, Tabatabaie F. Study of seroprevalence and risk factors for Toxoplasma gondii among pregnant women in Karaj township of Alborz province [2013]. J Entomol Zool Stud. 2014;2(6):217-9.
15. Eshratkhah Mohammadnejad A, Eslami G, Shamsi F, et al. Prevalence of food-borne *Toxoplasma* in pregnant women population of Urmia, Iran. J Food Qual Hazards Control. 2018;5(1):17-23.
16. Chaudhry SA, Gad N, Koren G. Toxoplasmosis and pregnancy. Can Fam Physician. 2014;60(4):334-336.
17. Maldonado YA, Read JS. Diagnosis, treatment, and prevention of congenital toxoplasmosis in the United States. Pediatrics. 2017;139(2). doi:10.1542/peds.2016-3860
18. Iqbal J, Khalid N. Detection of acute *Toxoplasma gondii* infection in early pregnancy by IgG avidity and PCR analysis. J Med Microbiol. 2007;56(Pt 11):1495-1499. doi:10.1099/jmm.0.47260-0
19. Rosso F, Les JT, Agudelo A, et al. Prevalence of infection with *Toxoplasma gondii* among pregnant women in Cali, Colombia, South America. Am J Trop Med Hyg. 2008;78(3):504-508.
20. Razzak AH, Wais SA, Saeid AY. Toxoplasmosis: the innocent suspect of pregnancy wastage in Duhok, Iraq. East Mediterr Health J. 2005;11(4):625-632.
21. Roc ML, Palacián MP, Lomba E, Monforte ML, Rebaje V, Revillo Pinilla MJ. [Serologic diagnosis of congenital toxoplasmosis]. Enferm Infecc Microbiol Clin. 2010;28(8):517-519. doi:10.1016/j.eimc.2009.11.004
22. Nowakowska D, Stray-Pedersen B, Spiewak E, Sobala W, Małafiej E, Wilczyński J. Prevalence and estimated incidence of *Toxoplasma* infection among pregnant women in Poland: a decreasing trend in the younger population. Clin Microbiol Infect. 2006;12(9):913-917. doi:10.1111/j.1469-0691.2006.01513.x
23. Babaie J, Amiri S, Mostafavi E, et al. Seroprevalence and risk factors for *Toxoplasma gondii* infection among pregnant women in Northeast Iran. Clin Vaccine Immunol. 2013;20(11):1771-1773. doi:10.1128/cvi.00125-13
24. Foroutan-Rad M, Khademvatan S, Majidiani H, Aryamand S, Rahim F, Malehi AS. Seroprevalence of *Toxoplasma gondii* in the Iranian pregnant women: a systematic review and meta-analysis. Acta Trop. 2016;158:160-169. doi:10.1016/j.actatropica.2016.03.003
25. Shirdel S, Sharbatkhori M, Pagheh AS, Dadimoghadam Y, Soosaraie M, Gholami S. Seroepidemiology of *Toxoplasma gondii* infection in pregnant women and risk factors of the disease in Golestan province, Iran. Journal of Mazandaran University of Medical Sciences. 2017;27(152):63-71. [Persian].
26. Ebrahimzadeh A, Mohammadi S, Salimi-Khorashad A, Jamshidi A. Seroprevalence of toxoplasmosis among pregnant women referring to the reference laboratory of Zahedan, Iran. Zahedan J Res Med Sci. 2013;15:32-5.
27. Anvari Tafti MH, Ghafourzadeh M. Seroepidemiology of Toxoplasma infection in pregnant women in Yazd in 2012. Tolooebehdasht. 2014;13(3):116-125. [Persian].
28. Mohaghegh MA, Kalani H, Hashemi M, et al. Toxoplasmosis-related risk factors in pregnant women in the North Khorasan province, Iran. International Journal of Medical Research & Health Sciences. 2016;5(8):370-4.
29. Abdi J, Shojaee S, Mirzaee A, Keshavarz H. Seroprevalence of toxoplasmosis in pregnant women in Ilam province, Iran. Iran J Parasitol. 2008;3(2):34-7.
30. Yad Yad MJ, Jomehzadeh N, Jafar Sameri M, Noorshahi N. Seroprevalence of anti-*Toxoplasma gondii* antibodies among pregnant woman in South Khuzestan, Iran. Jundishapur J Microbiol. 2014;7(5):e9998. doi:10.5812/jjm.9998
31. Hazrati Tappeh K, Mousavi SJ, Bouzorg Omid A, Ali Nejad V, Alizadeh H. Seroepidemiology and risk factors of toxoplasmosis in pregnant women in Urmia city. The Journal of Urmia University of Medical Sciences. 2015;26(4):296-302. [Persian].

32. Hajsoleimani F, Ataeian A, Nourian A, Mazloomzadeh S. Seroprevalence of *Toxoplasma gondii* in pregnant women and bioassay of IgM positive cases in Zanjan, Northwest of Iran. Iran J Parasitol. 2012;7(2):82-6.
33. Garedaghi Y, Firozivand Y. Assessment of pregnant women toxoplasmosis by ELISA method in Miandoab city, Iran. Int J Women's Health Reprod Sci. 2017;5(1):72-5. doi:10.15296/ijwhr.2017.13
34. Sharbatkhori M, Dadi Moghaddam Y, Pagheh AS, Mohammadi R, Hedayat Mofidi H, Shojaee S. Seroprevalence of *Toxoplasma gondii* infections in pregnant women in Gorgan city, Golestan province, Northern Iran-2012. Iran J Parasitol. 2014;9(2):181-187.
35. Norouzi Larki Y, Sarkari B, Asgari Q, Abdolahi Khabisi S. Molecular evaluation and seroprevalence of toxoplasmosis in pregnant women in Fars province, Southern Iran. Ann Med Health Sci Res. 2017;7(1):16-19.
36. Ahmadpour GR, Ezatpour B, Hadighi R, et al. Seroepidemiology of *Toxoplasma gondii* infection in pregnant women in west Iran: determined by ELISA and PCR analysis. J Parasit Dis. 2017;41(1):237-242. doi:10.1007/s12639-016-0784-3
37. Mousavi M, Jamshidi A, Reisi JM. Serological study of toxoplasmosis among pregnant women of Nikshahr in 2012. Razi Journal of Medical Sciences. 2014;21(123):45-53. [Persian].
38. Zalei B, Pourmand D, Bilvaye S, Jalilzadeh Hamidi H. Seroepidemiology of toxoplasmosis in pregnant women referred to reference laboratory in Kermanshah, 2014-2015. J Clin Res Paramed Sci. 2016;5(2):125-131. [Persian].
39. Cheraghipour K, Sheykhian A, Maghsood A, Hejazi Z, Rostami Nejad M, Moradpour K. Seroprevalence study of Toxoplasmosis in pregnant women referred to Aleshtar rural and urban health centres in 2008. Yafteh. 2009;11(4):65-73. [Persian].