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Seroprevalence of *Toxoplasma gondii* Infection and Associated Risk Factors among High School Girls in Ibb City, Yemen

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Original Research Article

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Abstract: Toxoplasmosis has been described as the most widespread zoonotic disease of humans and other animals. Although *Toxoplasma gondii* infection in high school girls has been investigated in many countries, surveys have not been available in high school girls in Yemen. This study was performed to investigate the seroprevalence and risk factors associated with *T. gondii* infection among high school girls in Ibb city, Yemen. The study was carried out during the period February to December 2016. The sera from 220 volunteer girls were evaluated for *T. gondii* antibodies (IgM and IgG) using ELISA method. The seropositive rate of *T. gondii* was 18.2%, and 81.8% of high school girls was seronegative in anti-*Toxoplasma* IgG, while all cases (100%) were seronegative for IgM. Among the risk factors evaluated, only the presence of cats in home (p = 0.004) was observed as a significant risk factor associated with *T. gondii* infection. The results of this study may be useful for the design of optimal preventive measures against infection with *T. gondii*.
Keywords: Seroprevalence, Toxoplasmosis, ELISA, High school girls, Yemen.

INTRODUCTION

Toxoplasmosis is a widely distributed zoonotic disease caused by obligate intracellular apicomplexan protozoan *Toxoplasma gondii* that infects both birds and mammals [1, 2]. The parasite uses felines, including domestic cats, as definitive host, and warm-blooded animals, including humans, as intermediate hosts [3]. Up to a third of the world's population is infected by *T. gondii* and is reported to be an opportunistic parasitic infection in immune compromised hosts [4, 5]. The parasite is only known to reproduce sexually in the cat family. However, it can infect most types of warm-blooded animals, including humans.

Undercooked infected lamb is an important risk factor for human toxoplasmosis [6]. *T. gondii* is usually transmitted to humans by eating poorly cooked food that contains cysts, exposure to infected cat feces, and from mother to her fetus during pregnancy [7, 8].

The true importance of toxoplasmosis in humans remained unknown until the first reports of cases of congenital toxoplasmosis [9]. The prevalence and importance of toxoplasmosis in the world were reviewed by Robert-Gangneux and Dardé [10]. Among the majority of immuno-competent people, toxoplasmosis is usually asymptomatic, subclinical or benign [11]. However, in immune-compromised people, such as AIDS patients or pregnant women may become severe and life-threatening and it can occasionally be fatal [12, 13]. Congenital toxoplasmosis is associated with fetal death and abortion, and in infants, it is associated with neurologic deficits, neurocognitive deficits, and chorioretinitis [14]. So, toxoplasmosis is dangerous to two populations: immunocompromised patients and fetuses whose mothers acquire acute infection during pregnancy [15].

Diagnosis of toxoplasmosis can be carried out by direct detection of the parasite or by serological techniques. *T. gondii* antibodies are indicative of infection, and that infection is long lasting (generally thought to last throughout life). The diagnosis of recently acquired toxoplasmosis is generally based on the detection of specific IgM antibodies, followed by detecting the specific IgG antibodies 1 to 3 weeks later [16].

The most commonly used therapeutic regimen for toxoplasmosis is the combination of pyrimethamine with sulfadiazine and folic acid [4].

Studies on the prevalence of toxoplasmosis among high school girls and associated risk factors are unavailable in Ibb city, the study area, in particular and in Yemen in general. Therefore, this study was aimed to determine the seroprevalence of toxoplasmosis and its

associated risk factors among high school girls in Ibb city, Yemen.

MATERIALS AND METHODS

Study design, setting, and population

A cross-sectional study was carried out on 220 volunteer high school girls from three main public schools, namely Alsaeed, Aeshah, and 26 September in Ibb city, Yemen, from February to December 2016. Ibb city, the capital of Ibb Governorate (Figure 1), is located 194 km south of Sana'a, at an altitude of 2050 m (6,730 ft). Due to its high altitude, Ibb city has a subtropical highland climate, and is one of the wettest areas of Yemen, typically receiving 800–1200 mm of rain per annum.

Fig-1: Map of Yemen showing the location of the study area

Samples collection and questionnaire administration

In this study, a total of 220 blood samples were collected randomly in sterilized vacutainer tubes from public high school girls in Ibb city, Yemen, from February to December 2016. 10 ml of venous blood was aseptically collected by venipuncture into pre-labeled plain tubes and left to clot at room temperature. Sera were separated by centrifugation at 3000 rpm for 10 min and preserved at −20 ºC until analyzed.

A structured questionnaire was used to assess risk factors, which included: having cats at home, knowledge of toxoplasmosis, consumption of undercooked meat, dealing with raw meats without wearing gloves, consumption of raw or unwashed vegetables or fruits, and habitual hand wash. These characters were selected based on the available literature.

Serological investigations

The sera of volunteer girls were subjected to enzyme linked immunosorbent assay (ELISA) to measure IgG and IgM antibodies.

Statistical analysis

Collected data were analyzed using SPSS version 11. The correlation between selected characters and seropositivity was analyzed by the Pearson's chisquare test. $P < 0.05$ was considered significant.

Ethical consideration

Before the commencement of this study, permission was obtained from the school principals and consent was obtained from participants. Participation was voluntary and all participants were informed of the study aims, procedures, and benefits of the study. Before the commencement of sample collection, signed or thumb-printed consent was obtained from the participants. All blood samples were collected using new disposable tubes, syringes, and needles. The blood samples of participants and results were anonymised.

RESULTS AND DISCUSSION

Although most studies in the world on the epidemiology of *T. gondii* infection are focusing on pregnant women [17-20, 1], childbearing age [21-23], and immunodeficient patients [24-26], little studies are carried out on high school girls. The present study was performed to investigate the seroprevalence of *T. gondii* infection in high school girls in Ibb city, Yemen. Blood samples of 220 high school girls aged between 15 and 19 were analyzed for *T. gondii* IgG and IgM antibodies using ELISA method. From the results presented in Table (1), 39 cases (17.7%) were seropositive and 181 cases (82.3%) were seronegative for IgG, while all cases (100%) were seronegative for IgM. These results could be explained by the fact that the group examined consisted only of healthy girls, and IgG-positive girls were infected with latent toxoplasmosis without a persistence of IgM after acute infection in the past. The

population studied is located within the capital of Ibb governorate, and its climatic and living conditions favor many parasites. In comparison, this seroprevalence (17.7%) was lower than previous prevalence values recorded in Ajabshir (East Azarbaijan Province, Iran) (38.3%) [27], Bushehr city (South-west of Iran) (22.1%) [28], and São Jerônimo da Serra city, Brazil (50%) [29], but was higher than recorded in Fasa District (Iran) (10%) [30], and nearly similar to previous prevalence value recorded in Guadalajara (Jalisco, Mexico) (17.8%) [31].

Table-1: Distribution of anti-*Toxoplasma* IgG and IgM

Antibody	Positive		Negative	
	No.	%	No.	%
IgG	39	17.7	181	82.3
IgM	0	0	220	100

The causes for these seroprevalence variations are attributed to environmental conditions (e.g. climate, rainfall, temperature, soil type, and altitude) and girls' characteristics such as management of cats and hygienic practice. The study area has an elevation of 2050 meters above sea level, and high altitude doesn't favor oocyst sporulation and survival. In high altitudes, the prevalence of *T. gondii* infection has been found lower as compared to low altitudes [32, 33].

There are various reports about the greater risk of acquiring *T. gondii* infection in people who have cats [1, 21]. In this study, it was found that having cats at home was a significant risk factor for girls to acquire *T. gondii* infection ($p = 0.004$). Cats are the definitive host of *T. gondii* and considered as the major source of *T. gondii* infection to human, because they can shed and excrete a plenty of resistant oocysts into the environment daily and provide the basis for the transmission of the parasite into the host [34, 35].

Although in this study 76.9% of girls didn't have any information about toxoplasmosis (e.g. how to transmit to human), there was no correlation ($p = 0.974$) between *Toxoplasma* seropositivity and primary information about toxoplasmosis (Table 2). Because of the high rate that high school girls in Ibb city don't have any information about toxoplasmosis, it is recommended to the policy makers and health managers to initiate health education programs as a primary preventive measure for toxoplasmosis in this city in particular and the whole country in general.

Consumption of undercooked meat is one of the generally accepted risk factors for infection with *T. gondii* [1, 23, 31], although no association was observed in this study ($p = 0.898$). This lack of an association might be due to an insufficient sample size. Therefore, further large-scale investigations are required in this area.

No significant relationship ($p = 0.984$) were found between seropositivity and wearing the gloves during dealing with raw meat, and the seropositivity was high (64.1%) in girls who wore gloves compared to the seropositivity (35.9%) in girls who didn't wear gloves during dealing with raw meat.

Although the consumption of raw or unwashed vegetables is also a potential source of *T. gondii* infection [23], it did not show significant association ($p = 0.947$) with the seroprevalence of *T. gondii* in this study, in agreement with previous studies conducted by Agmas *et al*. [1] and Galván-Ramírez *et al*. [31].

Although there was no significant correlation ($p = 0.948$) between *T. gondii* seroprevalence and the educational level, but seroprevalence was increased with the increase of level of education. The seroprevalence among girls in class 10 (first level), class 11 (second level), and class 12 (third level) were 12.8, 18, and 69.2%, respectively. The seroprevalence among girls of class 12 was nearly 4 times higher than those girls of class 10. This finding was in accordance with the observation of Fouladvand *et al*. [28], which reported that the seroprevalence of *Toxoplasma* among girls of class 12 was 2 times higher than those girls of class 10.

Generally, the absence of a statistically significant relationship between the seroprevalence of *T. gondii* infection and the above mentioned potential risk factors doesn't mean that they have no influence on the transmission of *T. gondii*. However, it may suggest that such factors play a limited role in the study area for the transmission of the parasite in the studied participants.

Table-2: Analysis of selected characteristics of the participant girls (n= 220) and *T. gondii* infection

Character	Number	Serostatus		*P*- value
		Positive No. (%)	Negative No. (%)	
Cats at home				
Yes	35 (15.9)	6 (15.4)	29 (16)	0.004*
No	185 (84.1)	33 (84.6)	152 (84)	
Knowledge about toxoplasmosis				
Yes	58 (26.4)	9 (23.1)	49 (27.1)	0.974
No	162 (73.6)	30 (76.9)	132 (72.3)	
Consumption of undercooked meat				
Yes	38 (17.3)	4 (10.3)	34 (18.8)	0.898
No	182 (82.7)	35 (89.7)	147 (81.2)	
Dealing with raw meats without wearing gloves				
Yes	73 (33.2)	14 (35.9)	59 (32.6)	0.984
No	147 (66.8)	25 (64.1)	122 (67.4)	
Consumption of raw or unwashed vegetables				
Yes	52 (23.6)	7 (18)	45 (24.9)	0.947
No	168 (76.4)	32 (82)	136 (75.1)	
Washing hands before eating				
Yes	178 (80.9)	33 (84.6)	145 (80.1)	0.947
No	42 (19.1)	6 (15.4)	36 (19.9)	
Educational level				
Class 10	35 (15.9)	5 (12.8)	30 (16.6)	0.948
Class 11	35 (15.9)	7 (18)	28 (15.5)	
Class 12	150 (68.2)	27 (69.2)	123 (67.9)	

CONCLUSION

Serological survey of toxoplasmosis in young girls before marriage and pregnancy, for identifying non-immune girls, could be used to prevent and control congenital toxoplasmosis. The results of this study demonstrated serological evidence of *T. gondii* exposure among high school girls, which may influence their health. The presence of cats in home was the only factor associated with *T. gondii* infection. So, it should be taken necessary preventive measures like proper disposal of cat feces and keep hygiene to avoid *T. gondii* infection. To the best of our knowledge, this is the first report of *T. gondii* seroprevalence in high school girls in Yemen. More studies should be conducted to further estimate the prevalence of *T. gondii* infection in high school girls in other places in Yemen.

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