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Seroprevalence of toxoplasmosis at referral hospitals in the northwestern region, Saudi Arabia

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Abstract:

BACKGROUND: Toxoplasmosis is induced by *Toxoplasma gondii*, which affects 30 percent of the global population and is responsible for deaths related to foodborne pathogens. This study aimed to describe the seroprevalence of *T. gondii* infections in patients attending referral hospitals in the northwestern region of Saudi Arabia.

MATERIALS AND METHODS: The serology test results for *T. gondii* antibodies of 797 patients were retrospectively analyzed using the hospitals' database. The enzyme-linked immunosorbent assay was used to detect *anti-T. gondii* antibodies (IgG and/or IgM).

RESULTS: Overall, the prevalence of anti-*T. gondii* antibodies was 8.3%. Higher (9.9%) prevalence of positive results among patients aged 30 years and above was observed. Statistically, the various age groups ($P = 0.031$) were found to be significant. Female was noted to have increased (8.1%) seroprevalence, and the incidence of infection occurred largely among participants living in rural areas (8.2%).

CONCLUSIONS: Toxoplasmosis remains a public health concern. The seroprevalence of *T. gondii* antibodies was relatively low in the study area. IgG antibodies to *T. gondii* were mainly detected. Increasing awareness on the mode of transmission, source of infection, and disease prevention through health education and dissemination is vital to reduce or eliminate toxoplasmosis.

Keywords:

Saudi Arabia, seroprevalence, *T. gondii*, toxoplasmosis

Introduction

Toxoplasmosis is induced by *Toxoplasma gondii*, a parasitic protozoan that is passed from animals to humans. About 30% of the global population is affected by this disease^[1] and caused 24% of deaths related to foodborne pathogens in the US.^[2] Approximately, 1 million cases of toxoplasmosis occur every year in Europe due to contaminated food.^[3] *Toxoplasma gondii* belongs to the Apicomplexa phylum; all its members are obligate endoparasites.^[4] It infects various intermediate hosts, like mice, rats, sheep, and humans, and affects numerous organs and tissues, including the eye, brain, and endothelium systems.^[5]

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People are infected by ingesting infective oocysts defecated in cat feces, or contaminated food, water, and soil. The main hosts are animals, but humans are infected through contracting with them directly. Additionally, eating uncooked or precooked meat of infected animals can cause infection through tissue cysts ingestion.^[6] In immunocompetent individuals, toxoplasmosis is usually asymptomatic, although it is more harmful in immunocompromised persons which might lead to fatal encephalopathy. Diseases in immunocompromised people are due to reactivations of innate disease, and congenital infections may not show up until later in life.^[7] Fetal death and severe damage to newborns may result from infection

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during early pregnancy, including retinochoroiditis, hydrocephalus, seizures, and intracerebral calcification.^[8]

Numerous study papers were done in Saudi Arabia regarding *Toxoplasma* infections and mostly on pregnant women. Across Najran and Jazan Provinces in the south of Saudi Arabia, prevalence ranges from 20.8% to 24.1%, and 38.8% in the southwest.^[9-11] Up to 32.5% (IgG positivity) and 6.4% (IgM positivity) of participants in a recent study in Riyadh had *T. gondii* antibodies.^[12] Dhahran, in the eastern region, showed seropositivity of 28.5% IgG and 3% IgM to *T. gondii*.^[13] In Al Madinah Munawara, a study revealed a prevalence of 21.3%.^[14] Moreover, *T. gondii* was detected in 47.7% and 21.2% of pregnant women in Makkah, respectively.^[15,16]

Generally, toxoplasmosis is diagnosed serologically and clinically. Patients with *Toxoplasma* infection develop antibodies within 2 weeks of exposure, but the serological analysis of antibodies is ineffective at distinguishing between chronic and acute infections.^[17] The detection of antibody IgM or both IgG and IgM is a positive result and indicative of an acute infection, whereas a negative result indicates either recent or no infection.^[18] Positive IgM can, however, be caused by faulty commercial test kits or residual IgM found in the blood when an acute infection has been completed. Studying seroprevalence can provide estimates on the number of people at risk and the magnitude of infection in a community. The general public hospitals of Hail region regularly screen for *T. gondii* infections during antenatal care. The purpose of this study was to determine the prevalence of *T. gondii* IgM and IgG antibodies in patients who visited referral hospitals in the northwestern region of Saudi Arabia. This study provides valuable health data that helps to improve the existing screening program and raise residents' awareness and preventive behaviors toward toxoplasmosis.

Materials and Methods

Study design and setting

This is a retrospective analysis of 797 serum sample reports for *Toxoplasma* IgG and IgM from January 2020 to December 2020. Located in the northwestern of Saudi Arabia (27.3 degrees North latitudes, 41 00 degrees East longitudes) is the region of Hail, with desert climate - hot during summers with an average of 29.2°C temperature, and 13.3°C average temperature during mild winter. The region is situated at a high elevation (1,140 meters above mean sea level) and receives a yearly rainfall of 100.6 millimeters [Figure 1].

Study participants and sampling

Patients who availed health services in Hail public hospitals and requested serological tests for *T. gondii*

antibodies between January 2020 and December 2020 were collected with their blood samples and included in the study. Any patients with missing relevant data or information and not residing in Hail region were excluded. The enzyme-linked immunosorbent assay (ELISA) kit (Roche Diagnostics GmbH, Mannheim, Germany) was used to detect the antibodies to *T. gondii* (IgG and IgM).^[19,20] Detection of antibodies, IgG and/or IgM indicates a positive reaction. In accordance with the manufacturer's guidelines, a seropositive sample has an analyte concentration of ≥ 3 IU/mL, whereas a seronegative sample has an analyte concentration of <1 IU/mL. Clinical samples with ≥ 1 to <30 IU/mL are considered borderline. If this occurs, the sample should be retested and repeated within 3 weeks.^[20]

Data collection tool and technique

The serum sample examination datasets for a total of 797 were obtained from the regional laboratory information system database department with prior approval from administration officials. Appropriate frequencies and percentages were utilized to describe the data and were analyzed using the SPSS (v. 22). The Chi-square test was applied to identify the correlations between variables, with a significant cut-off *P* value of <0.05 .

Ethical consideration

The research protocol was reviewed and approved by the Faculty of Applied Medical Sciences at University of Hail (AMS-05/21). The laboratory administrators also granted written permission. Patient privacy and data confidentiality were both kept. The information was only used for research purposes.

Results

Overall, 797 laboratory reports were reviewed and included in the study. The patients' ages range from 1 to 51 years, with a median age of 28 years. Anti-*T. gondii* antibodies (IgG and/or IgM) were found in 8.0% (64/797). Specifically, IgG and IgM prevalence rates were 7.3% (58/797) and 1.0% (8/797), respectively. Only two (0.3%) of the participants had anti-*T. gondii* IgG and IgM antibodies in their sera [Table 1].

The proportion of positive serum samples for anti-*T. gondii* IgG and/or IgM among different age groups revealed that patients aged ≥ 30 years had higher (9.9%) seropositivity than patients aged <30 years (5.8%). This notable difference was found to be significant, statistically ($X^2 = 1.801$, $P = 0.031$). Conversely, the prevalence rate of *T. gondii* IgG and/or IgM in females was higher than males with no statistically significant differences ($X^2 = 0.183$, $P = 1.000$) [Table 2]. Highest incidence of infections occurred among patients residing

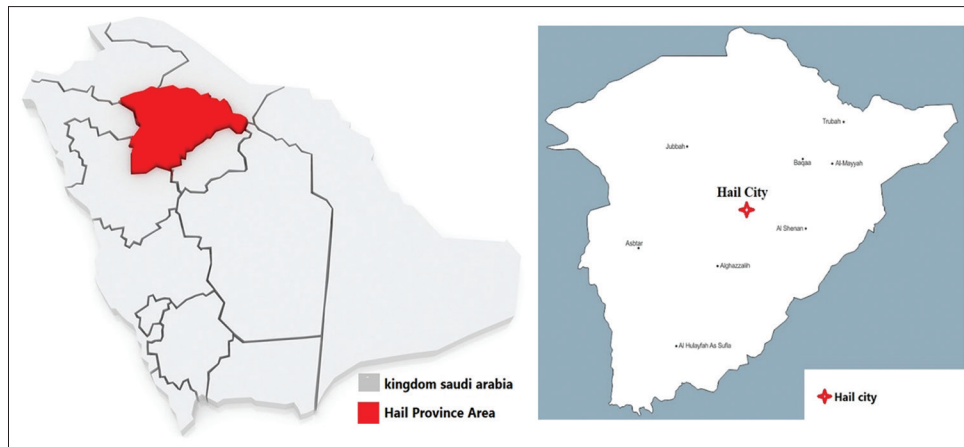


Figure 1: Geographic map showing Hail province area involved in the study

Table 1: Seroprevalence of *Toxoplasma gondii* IgG and/or IgM in patients at referral hospitals in Hail Province

Antibodies to <i>T. gondii</i>	Frequency	%
IgG only	58	7.3
IgM only	8	1.0
IgG and IgM	2	0.3
Total	64	8.0%

Table 2: Seroprevalence of *T. gondii* IgG and/or IgM in patients at referral hospital in Hail province stratified by age, gender, and residences (n=797)

	IgG and/or IgM		P
	Frequency	n (%)	
Age groups (years)			
<30	364	21 (5.8)	0.031
≥30	433	43 (9.9)	
Gender			
Male	47	3 (6.4)	1.000*
Female	750	61 (8.1)	
Residences			
Urban area	371	29 (7.8)	0.051
Rural area	426	35 (8.2)	

*Fisher's exact test

in rural areas (8.2%) than those who lived in urban areas (7.8%) but the difference was not significant as shown in Table 2.

Discussion

An overall seroprevalence of 8.0% was found in this study. Previous studies in Saudi Arabia reported higher seroprevalence rates.^[9-14] For instance, patients availing healthcare in both private and government facilities in Al Madinah Munawara revealed a prevalence of 21.3%.^[14] Moreover, patients attending hospitals in Dhahran, eastern region of Saudi Arabia, found a seropositive of 28.5% for *T. gondii* infection.^[13] Similarly, several countries including Brazil, Burkina Faso, Ethiopia, Lebanon, and Myanmar revealed much higher prevalence rates from

17.6% to 92.5%.^[21-25] Variations in *T. gondii* infections seroprevalence were noted throughout the world, and they have been attributed to various factors including methods of diagnosis with various sensitivity and the difficulties of controlling the differences among cohorts.

The increase prevalence of *T. gondii* infections in relation to age has been noted in various studies,^[26-28] and this is caused by the prolong exposure to the parasite.^[29] A similar pattern of findings was also noted in this present study. *T. gondii* has been estimated to have infected 23% of adolescents and adults.^[30] Toxoplasmosis is mostly acquired by consuming raw or uncooked meat contaminated with tissue cysts. Tissue cysts in meat are infectious as long as the meat is edible and raw. There has been a link to drinking unpasteurized contaminated milk, as well.^[31] In developing nations, unfiltered water could potentially lead to outbreaks. Children can become infected by ingesting oocysts from dirt or sandpits contaminated with feces from cats, particularly kittens, or other animals.^[31] In one to five days after excreting oocysts, the oocysts become infective, and they may be infectious for more than a year in moist soil or water.^[31] Toxoplasmosis can be acquired cumulatively, which rationalizes the increasing prevalence rate of the disease with increasing age because of the relationship between duration exposure to infective stages of *T. gondii*.^[32]

Generally, seroprevalence between different sexes rarely differs significantly. Several studies, however, have found that the prevalence is greater in either males^[33] or females.^[32] The present study revealed that *T. gondii* infection among female (8.1%) was slightly higher than male (6.4%) but no significant ($P > 0.05$). This is because male and female infection routes are similar due to shared risk factors. Contrary to the present study, the association between seropositivity and gender was evident ($P = 0.016$) in the study in Taiz, Yemen.^[32] This was caused by varying rates of

exposure to potential risk factors. Pregnant women, occupation that requires long contact with livestock and their products, and individuals who have compromised immune systems, like cancer patients, transplant recipients receiving immunosuppressive therapy, and people with AIDS, are at risk for getting the infection.^[34,35]

Apart from risks relating to individual health-promoting behaviors, the seroprevalence of *T. gondii* infections was observed to be affected by geographic trends.^[36,37] In this present study, the seroprevalence is greatly distributed among participants residing in rural areas compared to those inhabiting urban areas [Table 2]. This is consistent with other studies carried out internationally.^[38] In rural areas, people like to keep animals inside their houses, where more people interact with them. In addition, rural people engaged in practices such as eating sheep meat and locally grown vegetables, and cleaning barns which increased the exposure risk.^[36] The study area is mainly agricultural where they locally produce vegetables. Sheep meat is also locally available and abundant in this region, and the people regularly consume meat products. Across various meat products, the highest risk of contamination is meat from lambs.^[39] There is currently no data regarding the contamination of *T. gondii* to locally produced meat products from sheep or lamb in the study area.

However, studies conducted in different regions showed the prevalence of infections or contaminations. In Riyadh, the seropositivity of IgG was high (68%) in sheep while IgM seropositivity in sheep, goats, and camels was also reported in Najran (19%).^[40] Lower prevalence (11.9%) was observed in chicken in the province of Qassim.^[41] Similarly, eating uncleaned raw fruits and veggies has also been linked to an increased risk of infection. This risk factor is due to widespread contamination of oocysts in the local environment including water sources and soil.^[42,43]

Limitation and recommendation

The present study's findings have identified specific limitations that must be acknowledged. The absence of an avidity test prevented the researchers from determining the recency of *Toxoplasma* infection among the participants. By not employing this diagnostic tool, the authors were unable to ascertain whether the observed infections were recent or occurred in the past. Additionally, the researchers recognized the importance of incorporating a larger sample size to strengthen the statistical power and enhance the generalizability of the present findings and may have yielded different results. Finally, increasing the demographic variables of the participants could improve the generalizability of the results.

Conclusions

Toxoplasmosis remains a serious public health concern. The *T. gondii* antibodies seroprevalence was relatively low in the study area. IgG antibodies to *T. gondii* were mainly identified. The findings of this study suggest that preventive measures should be sustained. Increasing awareness on the mode of transmission, source of infection, and disease prevention through health education and dissemination is vital to reduce or eliminate toxoplasmosis. Integrating routine screening for *T. gondii* as part of the other primary health services and control programs is a valuable approach.

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Conflicts of interest

There are no conflicts of interest.

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