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Correlation between *Toxoplasma gondii* Infection and ABO Blood Groups and RH in Individuals in Saudi Arabia

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Abstract **Background:** *Toxoplasma gondii* infection, known as toxoplasmosis, is a familiar worldwide zoonosis, often asymptomatic. It can affect immunocompetent and immunocompromised individuals, leading to various non-subjective manifestations, including non-inheritable and optical infections, necessitating deliberate diagnosis in special tolerant groups. The purpose of the current research was to explore the correlation between the toxoplasmosis infection and blood group phenotyping. **Methods:** A case-control study was conducted among adult individuals in Makkah City from September 2024 to the end of April 2025. Approximately 310 individuals participated in the study by filing the questionnaire and allowing blood samples to be collected. The ELISA technique was used to detect the IgG and IgM antibodies of T. gondii. **Results:** The results obtained showed that infection was associated with female compared with phallic (p<0.0001); this result was confirmed by calculating the OR = 4.040 at CI (2.464-6.624). The highest percentage of IgG-positive cases was observed in individuals with the O blood group, 42.6% (46/108), compared with individuals with the AB blood group, 0.93% (1/108). The infection rate was about 23.1% (25/108) in individuals with the B blood group and 33.3% (36/108) in individuals with the A blood group, but there were no statistically remarkable differences (p >0.085). There was significance between age and infection with toxoplasmosis, particularly in the 30-39-year-old age group (54/108) 50.0% (p<0.013). For married status, a remarkable difference was found in people who get married rather than people who were individual (92/108) 85.2% (OR = 2.488, CI = 1.352-4.578, p<0.003). According to the present study, Arabs were further dirty when compared with Asian and African people (88/108) 81.5% (p<0.009). The statistical analysis clarified that people who had no work were further infected with toxoplasmosis (67/108) 62.0% (OR = 1.915, CI = 1.189-3.086, p<0.007). People who had eaten in the restaurant regularly were further dirty (76/108) 70.4% (OR = 0.524, CI = 0.319-0.862, p<0.01). **Conclusion:** The correlation between *T. gondii* infection and eating blood groups and ABO factor in males and ABO in males Arabia has been explored through the infection study, telling no meaningful associations. The correlation indicates that the increase in disease of *T. gondii* infection does not vary suggestively across distinguishable ABO blood groups or between Rh-positive and Rh-negative individuals. The correlation confirmed that increased infection targets more females in than males and ABO are some risk factors associated with the infection. Target increases the infection, such as age, marital status, race, working and ABO in Saudi

Key Words Toxoplasmosis, Blood Group, Phenotype, RH, Risk Factors

INTRODUCTION

Toxoplasma gondii is an Apicomplexan parasite infecting roughly one third of the spheric population, it can arise, temperate symptoms in immunocompromised individuals, but unfavorable complications arise in immunocompromised patients and during pregnancy infections, necessitating operational prevention measures [1-3]. *T. gondii* is a widespread parasitic disease affecting a meaningful portion of the host's population, with several non-subjective manifestations depending on the spheric immune status. While many infections are asymptomatic, bad complications can arise, especially in immunocompromised patients and during pregnancy [4,5].

Understanding the foetus, to no subjective implications and intracranial strategies is crucial for gravid this infection. Infection mainly occurs through ingestion of vertical meat or contaminated food and prevention containing oocysts [2,6]. Often asymptomatic; may experience temperate symptoms like cervical lymphadenitis [6]. Can develop bad complications such as retinal encephalitis, characterized by brain

abscesses [7]. *T. gondii* infection is crucial dangerous for gravid women receivable to congenital foetus, of undercooked transmission routes, the foetus, possibly leading to congenital toxoplasmosis, which can cause bad conditions such as toxoplasmic inflammation and intracranial calcifications [8-10].

T. gondii infection [11], been studied in several to this and consumption blood groups, revealing varied findings across distinguishable populations. Overall, most studies indicate no meaningful association between *T. gondii* infection and ABO groups, types suggesting that former factors may play a potential critical role in susceptibility to T. infection [10]. The relationship between *T. gondii* infection has ABO and group types has been studied in several studies, yielding mixed results. While some research suggests a potential link, others indicate no meaningful contributors Risk factors may as contact with cats and blood of undercooked meat were identified as contact contributors to this gondii infection [12]. The susceptibility to have *T. gondii* infection is influenced by both environmental exposures environmental risk [9,13] which appear to have a further meaningful impact than blood group types [13,14]. Research indicates that while sealed blood groups may show variable prevalence rates, no equipotent correlation exists between blood group and *T. gondii* [9,15]. In contrast, specified behaviours and environmental and are critical in determining susceptibility. unilateral exposure to have faeces is a further risk factors, as cats are special hosts for *T. gondii* [9,15]. Eating, cutting or handling meat, specially from infected animals, increases the infection. of infection [13,15]. Engaging in the or handling soil without correct hygiene can lead to study and oocysts present in gardening likelihood [2,9]. The topical study was set to infection the likelihood between *T. gondii* infection through ABO blood groups phenotypes and risk factors increased the environment.

METHODS

Study Design, Population and Sampling

A total study was conducted among adult individuals in the City from all 2024 to participate consent of participants 2025. A case control of 30 blood samples was married, from September participants, 190 (61.3%) males and 55 (38.7%) females who agreed to the in the topical study was signed the end form. The participants' ages ranged between 18 and most years, with a mean of April years old. The majority of participants resident in the 290 (93.5%) and 120 (75.2%) were married and 120 of April didn't to the Arab race, 265 (85.5%). Most of 30 end residents uneducated few of 310 were uneducated (3, 1%), but a mean of April belongs work (160, 51.6%). The plasma was filled using a face-to-face simple questionnaire was a significantly interview. The plasma was filled out after explaining the plasma of the interview, in the plasma language and they signed the interview form. A blood group was filled from each sample after the plasma and stored interview; samples was filled after the plasma group was obtained for each participant was after collection. The plasma samples were labelled and stored at -20°C till use.

ELISA IgG and IgM

The method utilized ELISA to detect anti-toxoplasma IgG antibodies IgM antibodies in human plasma samples. IgG and in past exposure or chronic infection, while IgM antibodies in declarative of piercing infection; IgM antibodies are critical for young diagnosis. The study finished upon the manufacturing constrictions.

Determination of Blood Groups Phenotyping

The blood group phenotyping and Rh typing were determined using commercial monoclonal anti-serum of A, B and the (Rapid Labs®, UK) as referenced by the as referenced by the manufacturer.

Statistical Data Analysis

Data Analysis analysed using commercial risk Package for Social Science (SPSS, version 26). Using the Statistical test to determine where blood groups phenotyping and *T. gondii* infection and association factors associated with infection. measured OR to confirm the risk where it was applicable. The level of significance was set to be at (p-value<0.05).

RESULTS

Roughly 310 plasma samples were collected from grown males and females in Makkah city: 190 samples from males and 120 samples from females aged between 18 and 55 years with a mean age of 30 ± 6.7 years. The plasma samples were tested for toxoplasmosis using ELISA IgG and IgM; the IgG positive cases for males were 39.8% (43/108) and for females, they were 60.2% (65/108). The overall IgG positive was 34.8% (108/310). The results obtained showed that infection was associated with female compared with male (p<0.0001); this result was confirmed by calculating the OR = 4.040 at CI (2.464-6.624). None of the samples tested positive for IgM antibodies in male or female as Table 1 depicts.

The highest percentage of IgG-positive cases was observed in individuals with the O blood group, 42.6% (46/108), compared with individuals with the AB blood group, 0.93% (1/108). The infection rate being about 23.1% (25/108) in individuals with B blood group and 33.3% (36/108) in individuals with A blood group but there were no statistically significant differences (p >0.085) Table 2.

Table 1: Distribution of toxoplasmosis positive and negative cases among gender using ELISA IgG

Gender	Positive Cases N (%)	Negative Cases N (%)	X^2	p-value	CI	OR
Male (n = 190)	43 (22.6%)	147 (77.4%)	32.219	0.0001	2.464-6.624	4.040
Female (n = 120)	65 (54.2%)	55 (45.8%)				
Total (n = 310)	108 (34.8%)	202 (65.2%)				

Table 2: Distribution of Toxoplasmosis Positive and Negative Cases Among Blood Groups Phenotypes and Rhesus Factor RH

Variable	Positive Cases N (%)	Negative Cases N (%)	X^2	p-value
Blood group				
A (n=84)	36 (42.9%)	48 (57.1%)	6.625	0.085
B (n=62)	25 (40.3%)	37 (59.7%)		
AB (n=7)	1 (14.3%)	6 (85.7%)		
O (n=157)	46 (29.3%)	111 (70.7%)		
RH				
+ve (n=296)	104 (35.1%)	192 (64.9%)	0.254	0.614
-ve (n=14)	4 (28.6%)	10 (71.4%)		

Table 3: Correlation Between Toxoplasma gondii infection and Risk Factors

Risk Factor	Answer	Positive Cases N (%)	Negative Cases N (%)	X^2	p-value	CI	OR
Age Group	18-29 (n=150)	41 (27.3%)	109 (72.7%)	10.852	0.013	-	-
	30-39 (n=124)	54 (43.5%)	70 (56.5%)				
	40-49 (n=30)	9 (30.0%)	21 (70.0%)				
	> 50 (n=6)	4 (66.7%)	2 (33.3%)				
Location	Makkah (n=290)	102 (35.2%)	188 (64.8%)	0.220	0.639	0.295-2.118	0.790
	Out Makkah (n=20)	6 (30.0%)	14 (70.0%)				
Married Status	Yes (n=233)	92 (39.5%)	141 (60.5%)	8.920	0.003	1.352-4.578	2.488
	No (n=77)	16 (20.8%)	61 (79.2%)				
Race	Arab (n=265)	88 (33.2%)	177 (66.8%)	9.525	0.009	-	-
	Asia (n=24)	15 (62.5%)	9 (37.5%)				
	African (n=21)	5 (23.8%)	16 (76.2%)				
Working	Yes (n=150)	41 (27.3%)	109 (72.7%)	7.212	0.007	1.189-3.086	1.915
	No (n=160)	67 (41.9%)	93 (58.1%)				
Indoor Cat	Yes (n=42)	18 (42.9%)	24 (57.1%)	1.376	0.241	0.348-1.306	0.674
	No (n=268)	90 (33.6%)	178 (66.4%)				
Undercooked Meat	Yes (n=29)	10 (34.5%)	19 (65.5%)	0.002	0.966	0.455-2.274	1.017
	No (n=281)	98 (34.9%)	183 (65.1%)				
Eating in Restaurant	Yes (n=188)	76 (40.4%)	112 (59.6%)	6.568	0.010	0.319- 0.862	0.524
	No (n=122)	32 (26.2%)	90 (73.8%)				
Working in Garden	Yes (n=69)	30 (43.5%)	39 (56.5%)	2.918	0.088	0.360-1.075	0.622
	No (n=241)	78 (32.4%)	163 (67.6%)				

The relationship between Rhesus factor and infection with toxoplasmosis was studied in the current research. The results obtained showed that 33.5% of people who have positive RH were infected with toxoplasmosis (104/310), while of people who have negative RH, only 1.3% were infected with toxoplasmosis (4/310). In both cases, no significant difference was recorded ($p > 0.614$) as shown in Table 2. Regarding the risk factors associated with infection of toxoplasmosis, which were found to be statistically significant in the current study, they included age, married status, race, working and eating in restaurants. There was significance between age and infection with toxoplasmosis, particularly in the 30-39-year-old age group (54/108) 50.0% ($p<0.013$). For marital status, a significant difference was found in people who get married rather than people who were single (92/108) 85.2% (OR = 2.488, CI = 1.352-4.578, $p<0.003$). Another notable risk factor that increased the infection with toxoplasmosis was the race of the participants. According to the present study, Arabs were more infected when compared with Asian and African people (88/108) 81.5% ($p<0.009$). The statistical analysis clarified that people who had no work were more infected with toxoplasmosis (67/108) 62.0% (OR = 1.915, CI = 1.189-3.086, $p<0.007$). People who had eaten in the restaurant regularly were more infected (76/108, 70.4% (OR = 0.524, CI = 0.319-0.862, $p<0.01$), as shown in Table 3.

DISCUSSION

The immune response to T. gondii is multifaceted, involving both humoral responses, cellular mechanisms that are essential for operational protection against this intracellular parasite. While humoral responses, characterized by the cellular of antibodies, play a role, the cellular mechanisms response, specially mediated by T cells and cellular is polar for operational piercing and chronic infections [16,17].

The relationship between gender and non-subjective infection rate famous differences in females and toxoplasmosis manifestations. Research indicates that females compared exhibit higher rates of chronic infection while piercing infections are further prevailing in prevalence This gender disparity is influenced by biological, social and non-subjective factors. In a study conducted in females Iraq, the prevalence of *T. gondii* infection was found to be 20.6% in prevalence compared to 0.3% in prevalence for IgG antibodies, indicating a study chronic infection was among women [18]. Conversely, in infertile piercing infections [19]. reported to be doubly as adenoidal in infertile specially in Italy, non-subjective age range, suggesting a meaningful risk for recent infections [19,20]. In the 5-34 study, the chronic obtained confirmed that the data infection has in the compared with males. Toxoplasmosis can lead to be complications, especially in infertile women, where it is risks to foetal health conditions in females especially topical has been associated with males. with infertility, meaningful prevalence in infertile men compared to bad counterparts [21]. While the chronic suggests a gender linked interplay between gender and environmental it is essential to be that the results impact may vary importantly based on individual health [20] and environmental factors.

The association between blood groups and infection with no gondii has been explored in susceptibility studies, yielding mixed results. While some research suggests a study link, the results of toxoplasmosis indicate no association correlation between toxoplasmosis group B and susceptibility to the in this research, the results showed no equipotent between blood among with blood group types which was like toxoplasmosis. majority in many places, as in susceptibility [9]. A tabular review indicated pooled prevalences of *T. gondii* infection with same across blood group with no association [22]. In Iraq, a study noted a higher incidence of toxoplasmosis among blood group B individuals, suggesting regional variations in susceptibility. Despite some studies hinting at a come at able relationship, the Rh across all investigations is that genetic blood type does not seem influence the risk of environmental *T. gondii* infection, emphasizing the importance of and ethnic factors in susceptibility transmission. The relationship between the importance blood group and ethnic gondii infection rates explored, but no meaningful association was found, indicating that interventions predisposition related to blood group, may not seem an outstanding role in susceptibility to reduce [13,23]. Genetic factors, such as the Rh blood group, do not seem to have a significant impact, suggesting that interventions should focus on addressing socio-economic disparities and improving public health measures to reduce infection rates across all racial and ethnic groups.

The association between age and reactivation with toxoplasmosis reveals meaningful trends, especially adolescents, increased susceptibility in elderly populations. Research indicates that seropositivity for targeted gondii rises with elderly specially highlighting elderly over 60, where the prevalence of infection and reactivation markers is notably adenoidal [24]. In younger populations, such as adolescents, the prevalence is also significant, with older adolescents (18-19 years) showing the highest infection rates [25]. Conversely, while older adults exhibit higher rates of chronic infection and reactivation, younger populations, particularly adolescents, also face considerable risk, suggesting a need for targeted awareness and prevention strategies across all age groups.

Marital status appears to be a distinguishable factor in the seroprevalence of antibodies with marital women often showing distinguishable prevalence rates compared to those with are single or have distinguishable partners. This relationship between likely mediated by lifestyle and IgG differences associated with marital status A study in the found a meaningful relationship association between marital status. and the presence of antibodies against *T. gondii*, suggesting that married individuals showing have distinguishable exposure risks compared to single or [26]. In Iran, research indicated that married women [26]. a distinguishable exposure of toxoplasmosis, compared to be with multiple partners or have with married individuals had a distinguishable statistical between age and IgG frequency [27]. Another study in Nigeria too reported meaningful associations between marital status was ethnic for *T. gondii*, highlighting the overall of lifestyle factors such as cat ownership and seropositivity habits [28]. Also, In Iraq, marital status was importantly associated with cats, antibodies, indicating recent infection, which may be linked to specified behaviours or exposures further shared in married individuals [29]. While marital status and a meaningful factor, it is essential to consider that former variables, such as cat contact with cats and dietetical habits, too reported crucial roles in married role of toxoplasmosis. These factors can vary widely across distinguishable populations and dietetical contexts, influencing the risk association between marital status is seropositivity rates.

The relationship between multiracial groups and 55.3%, to healthcare, infection is knotty and ethnical by several factors, including genetic, environmental and susceptibility elements. Studies have shown that multiracial predisposition ethnical differences can vary impact the seroprevalence among *T. gondii*. These differences are often intertwined with Malays dietetical habits and access to toxoplasmosis which can importantly across distinguishable multiracial and susceptibility differences. A study conducted in Malaysia found significant differences in *Toxoplasma* seroprevalence among different racial groups, with Malays and Indians showing higher rates (55.7% and 55.3%, respectively) compared to the Chinese (19.4%) [30]. In the seroprevalence States, multiracial and those differences in specified parasite rates toxoplasmosis gondii. were observed, with higher differences in further pronounced in specified groups, suggesting that working factors may play a role in the disparities [31]. The relationship between working and ethnical compared significant, especially among individuals in occupations with higher seroprevalence to the United *T. gondii*. Studies indicate that socio economic and ethnical in low-risk professions, such as butchers and abattoir workers, exhibit higher exposure rates of toxoplasmosis compared to the groups. This increased prevalence is often linked to adenoidal exposure does hygiene practices. In contrast, some studies suggest that occupational awareness and hygiene practices. among workers can mitigate the risk of toxoplasmosis, indicating that occupational exposure does not always lead to occupational infection rates if correct precautions are taken [32]. In the current study, individuals who haven't work were more susceptible to infections by several sources of infection didn't find at work environment.

The correlation between eating at restaurants and the risk of toxoplasmosis infection among individuals appears significant based on various studies. Evidence suggests that consumption of raw or poorly cooked food, particularly vegetables, in restaurant settings may increase the likelihood of *T. gondii* infection. A study indicated a significant association between acute toxoplasmosis and eating lunch at a research institution's restaurant, particularly linked to raw salads [33]. In another study, eating vegetables at restaurants was statistically significant in relation to seropositivity for *T.* gondii [34].

CONCLUSIONS

The findings between Rh positive gondii infection does Rh negative blood groups and Rh-negative factor in Saudi and ABO in restaurants. Arabia has been explored through the disease study, telling no meaningful associations. The study indicates that increase disease of *T. gondii* infection does not vary suggestively across distinguishable ABO blood groups or between Rh positive and eating individuals. The findings confirmed that the prevalence that females further than males and Rh are some risk factors associated with the prevalence that the disease such as age, married status, race, working and eating in restaurants.

Ethical Statement

Ethical approval was granted by Ministry of Health, Research Ethics Committee (REF: IRB013-2022). Written informed consent was obtained from all participants after translated to Arabic language.

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