

Original Article

Evaluation of *T. gondii*, rubella, and cytomegalovirus seroprevalences among female Syrian refugees in Sanliurfa, Turkiye

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Abstract

Introduction: Since the Syrian Civil War began in 2011, the official number of refugees under temporary protection in Turkiye is reported to be 3,522,036 in 2023. Most of the Syrians living outside the refugee camps have worse conditions in terms of access to healthcare centers and social opportunities, compared to those living in camps. The Sanliurfa province hosts the third highest number of Syrians (370,291) in Turkiye. There are no data about the seroprevalence of *Toxoplasma gondii* (*T. gondii*), rubella (rub), or cytomegalovirus (CMV) among Syrian refugees in Sanliurfa. We aimed to investigate the seroprevalence of *T. gondii*, rub, and CMV infections among female Syrian refugees of reproductive age (15-49 years) living in Sanliurfa province.

Methodology: A cross-sectional study was conducted in different districts of Sanliurfa. A total of 460 households were selected using the probability sampling method. One married female Syrian refugee aged between 15 and 49 years, was chosen in each household, leading to a sample size of 410 female Syrian refugees. The seropositivity of *T. gondii*, CMV, and rub IgM and IgG in blood samples were analyzed using enzyme immunoassays (Abbott Architect, Illinois, USA).

Results: The seropositivity rates of *T. gondii*, CMV, and rubella IgM and IgG were 4.4% and 59.8%; 3.9%; and 99%; and 1.9%, and 99.5%, respectively.

Conclusions: A screening program should be implemented for *T. gondii*, CMV, and rub infections for Syrian refugees. Seronegative women should be vaccinated against rub and educated about the transmission and preventive routes of toxoplasmosis and CMV infection.

Key words: *Toxoplasma gondii*; cytomegalovirus; rubella.

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Introduction

Several viruses, bacteria, and parasites cause infections that can be transmitted from mother to fetus and/or newborn child. Routine screenings for toxoplasmosis, rubella, cytomegalovirus (CMV) and herpes simplex virüs (TORCH) have been used for evaluation of *Toxoplasma gondii* (*T. gondii*), rubella virus and cytomegalovirus (CMV), and herpes simplex virus (HSV) which are the most common pathogens causing congenital and perinatal infections. These pathogens result in mild or asymptomatic infection in the mother; however, they can cause intra-uterine growth retardation, and serious congenital abnormalities in the developing fetus [1-4].

T. gondii is an obligate intracellular protozoan that infects humans and different animals. It causes congenital toxoplasmosis with major ocular and

neurological consequences, abortion, or zoonosis [5]. The seroprevalence of *T. gondii* infection in females of reproductive age or pregnant women ranges between 10% and 75%, depending on the culture and eating habits in different countries of the world [6]. *T. gondii* is generally transmitted horizontally during consumption of raw or undercooked meat, including tissue cysts; by ingesting food and water contaminated with oocysts from infected cat faeces; or oral ingestion of infectious oocysts from the environment. The pathogen is transmitted vertically by transplacental movement from mother to child, accidental injection with tachyzoites, and during breastfeeding [5-9].

Rubella is a highly contagious disease caused by a virus. The rubella virus is a single-stranded positive-sense RNA virus. Rubella is an acute, contagious viral infection that is transmitted by airborne droplets when

infected people sneeze or cough. Rubella has serious consequences in pregnant women because it causes fetal death or congenital rubella syndrome with neurological and endocrinological sequelae, cardiac malformations, sensorineural hearing loss, and cataracts. According to the World Health Organisation (WHO), there is no specific treatment for rubella but it can be prevented by immunization [10].

CMV is a member of the herpes virus family and is an enveloped DNA virus. CMV infection is common throughout the world with significant geographical variability [11]. CMV establishes a lifelong latent infection following primary infection that can periodically reactivate with the shedding of infectious viruses. It has been reported that CMV infection among pregnant women occurs most frequently through close contact with young children or through sexual transmission [12]. CMV screening is not among the routine antenatal screening and monitoring tests. CMV testing is done only when there is a need to determine the severe effects on infants' development [13].

Approximately 6.8 million Syrians have been displaced internally and 5.5 million Syrians have been displaced into neighboring countries such as Türkiye, Lebanon, Iraq, Egypt, and Jordan due to the civil war. As of 2022, Türkiye has hosted the largest number of Syrians with a total of 3,522,036 refugees by 1 December 2022, due to the open gate policy and the long border with Syria. Among these displaced Syrians, 59,877 live in temporary refugee camps, while the remaining 3,559,041 live outside of refugee camps. [14,15] The real number is believed to be higher than the reported data.

Most of the Syrians living outside of the camps have worse conditions in terms of well-being, access to healthcare centers and social opportunities, compared to those living in camps. They are exposed to early marriage, polygamy, prostitution, rising rental prices, and the reaction of the local poor people; in spite of the government's existent aid to refugees. Sanliurfa province in the southeastern Anatolia Region has the third highest number of Syrian refugees in Türkiye. Sanliurfa hosts approximately 370,291 Syrian refugees [14].

There is a lack of data concerning the seroprevalence of *T. gondii*, rubella, and CMV antibodies in Syrian refugees. Therefore, a cross-sectional study was designed to determine the seroprevalence of these antibodies among Syrian refugees living outside of camps in Sanliurfa.

Methodology

Enzyme-linked immunosorbent assay (ELISA) is the most frequently used and highly sensitive and specific method for detecting IgM and IgG antibodies in order to screen and diagnose TORCH infections [16].

A cross-sectional study including Syrian female refugees was conducted between April and May 2015 in different districts of Sanliurfa. The study was conducted in collaboration with the United Nations Population Fund and the Sanliurfa Governorate. This study was approved by the Ethics Committee of the Faculty of Medicine at Harran University. A total of 460 houses were selected using the probability sampling method. One married female Syrian refugee, aged between 15 and 49 years, was chosen from each house. Thus, the study sample consisted of 410 female Syrian refugees. Blood samples taken from the participants were centrifuged, and stored at -80 °C until they were tested. The seropositivity of *T. gondii* IgM and IgG, CMV IgM, and IgG, and rubella IgM and IgG were analyzed by qualitative and quantitative methods (ELISA) with commercially available enzyme immunoassays (Abbott Architect, Abbott Laboratories, Illinois, USA). The index values were accepted as CMV IgG < 6.0 AU/mL negative, CMV IgM \geq 1.00 index positive, CMV IgG avidity < 50.0% low avidity, 50.0–59.9 % greyzone, \geq 60.0% high avidity; rubella IgG \geq 10.0 IU/mL positive, rubella IgM \geq 1.60 index positive; toxo IgG \geq 3.0 IU/mL positive, *T. gondii* IgM \geq 0.60 index or \geq 1.00 S/CO positive, *T. gondii* IgG avidity \geq 60.0%; high avidity according to manufacturer's instructions.

Results

A total of 460 houses were selected using the probability sampling method. One married female Syrian refugee aged between 15 and 49 years was selected from each house. Our study included 410 female Syrian refugees.

In our study, positivity rates of *T. gondii*, rubella, and CMV immunoglobulin G (IgG), and immunoglobulin M (IgM) antibodies were determined to detect the seroprevalence of the three pathogens. ELISA was used to detect the seroprevalence of *T. gondii*, rubella, and CMV. The mean age of the participants was 29.91 ± 0.45 years.

Positive *T. gondii* IgG antibody was identified in 59.8% Syrian refugees and 4.4% were positive for the *T. gondii* IgM antibody. A total of 14 (3.4%) samples were seropositive for both IgM and IgG antibodies. 14 samples that were positive for *T. gondii* IgG and IgM had high avidity antibodies, prior to infection.

Table 1. The prevalence of Toxo IgM, Toxo IgG, rubella IgM, rubella Ig G, CMV IgM, and CMV IgG among Syrian refugees.

	Positive		Negative		Total	
	n	%	n	%	n	%
Toxo IgM	18	4.4	392	95.6	410	100.0
Toxo IgG	245	59.8	165	40.2	410	100.0
Rubella IgM	8	1.9	402	98	410	100.0
Rubella IgG	408	99.5	2	0.5	410	100.0
CMV IgM	16	3.9	394	95.8	410	100.0
CMV IgG	406	99.0	4	1.0	410	100.0

Toxo: *Toxoplasma*; CMV: cytomegalovirus.

Rubella IgG seropositivity was detected in 99.5%, and rubella IgM was detected in 1.9% tested samples. CMV IgG and IgM positivities were detected in 99% and 3.9% sample, respectively. Among all samples 13 (3.1%) were seropositive for both CMV IgM and CMV IgG antibodies. 13 samples that were positive for IgG and IgM antibodies to CMV had high avidity antibodies, prior infection. Table 1 summarizes *T. gondii*, CMV, and rubella seropositivity and seronegativity among the Syrian women.

Among the Syrian women included in the study, 56 women were pregnant. Among them, positive *T. gondii* IgG antibody was found in 62.5%, while 7.2% were positive for the *T. gondii* IgM antibody. Rubella IgG seropositivity was found 100%, and rubella IgM was found 1.8% women. CMV IgG and IgM positivities were detected in 98.2% and 0% women, respectively. Table 2 summarizes the *T. gondii*, CMV, and rubella seropositivity and seronegativity data among pregnant Syrian women.

Of the 410 Syrian women who participated in the study, 175 (42.6%) had a history of previous pregnancy losses, abortus, and stillbirth. Among the 175 women with pregnancy loss, positive *T. gondii* IgG antibody was identified in 63.4%, while 5.1% were positive for

the *T. gondii* IgM antibody. Rubella IgG seropositivity was found in 99.4%, and rubella IgM was found in 1.1%. CMV IgG and IgM positivities were detected in 98.9% and 4.0% respectively. Table 3 presents *T. gondii*, CMV, and rubella seropositivity and seronegativity among women with pregnancy loss.

T. gondii IgG seropositivity rate was the highest in the 26–35 years age group (41.3%) and the lowest in the 36–45 years age group (21.7%) ($p = 0.001$). *T. gondii* IgM seropositivity rate was the highest in the 15–25 years age group (44.4%) and the lowest in 36–45 years age group (16.7%) ($p = 0.001$).

Rubella IgG seropositivity rate was the highest in the 26–35 years age group (39.7%) and the lowest in 36–45 years age group (21.6%) ($p = 0.001$). Rubella 42.9% in the 15–25 years age group ($p = 0.001$). Rubella IgM seropositivity was not detected in the 36–45 years age group. IgM seropositivity rate was the highest in the 26–35 years age group (57.1%).

CMV IgG seropositivity rate was the highest in the 26–35 years age group (39.8%) and the lowest in 36–45 years age group (21.6%) ($p = 0.001$). CMV IgM seropositivity rate was the highest in the 15–25 years age group (53.3%) and the lowest in the 26–35 years age group (20%) ($p = 0.001$). Statistical analysis was

Table 2. The prevalence of Toxo IgM, Toxo IgG, rubella IgM, rubella Ig G, CMV IgM, and CMV IgG among pregnant Syrian refugees.

	d		Negative		Total	
	n	%	n	%	n	%
Toxo IgM	4	7.2	52	92.9	56	100.0
Toxo IgG	35	62.5	21	37.5	56	100.0
Rubella IgM	1	1.8	55	98.2	56	100.0
Rubella IgG	56	100.0	0	0.0	56	100.0
CMV IgM	0	0.0	56	100.0	56	100.0
CMV IgG	55	98.2	1	1.8	56	100.0

Toxo: *Toxoplasma*; CMV: cytomegalovirus.

Table 3. The prevalence of Toxo IgM, Toxo IgG, rubella IgM, rubella Ig G, CMV IgM, and CMV IgG among women with pregnancy loss.

	Positive		Negative		Total	
	n	%	n	%	n	%
Toxo IgM	9	5.1	166	94.8	175	100.0
Toxo IgG	111	63.4	64	36.5	175	100.0
Rubella IgM	2	1.1	173	98.8	175	100.0
Rubella IgG	174	99.4	1	0.6	175	100.0
CMV IgM	7	4.0	168	96.0	175	100.0
CMV IgG	173	98.9	2	1.1	175	100.0

Toxo: *Toxoplasma*; CMV: cytomegalovirus.

Table 4. The distribution of Toxo IgM, Toxo IgG, rubella IgM, rubella IgG, CMV IgM, and CMV IgG according to age groups.

	15-25 years age group		26-35 years age group		36-45 years age group		Total		p value
	n	%	n	%	n	%	n	%	
Toxo IgM positive	8	44.4	7	38.9	3	16.7	18	4.6	χ^2 : 341.161
Toxo IgM negative	142	38.4	146	39.5	82	22.2	370	95.4	p: 0.001
Toxo IgG positive	87	37.0	97	41.3	51	21.7	235	60.6	χ^2 : 15.610
Toxo IgG negative	63	41.2	56	36.6	34	22.2	153	39.4	p: 0.001
Rubella IgM positive	3	42.9	4	57.1	0	0.0	7	1.8	χ^2 : 379.623
Rubella IgM negative	148	38.7	149	39.0	85	22.3	382	98.2	p: 0.001
Rubella IgG positive	150	38.7	154	39.7	84	21.6	388	99.5	χ^2 : 404.039
Rubella IgG negative	1	50.0	0	0.0	1	50.0	2	0.5	p: 0.001
CMV IgM positive	8	53.3	3	20.0	4	26.7	15	3.9	χ^2 : 349.491
CMV IgM negative	143	38.2	150	40.1	81	21.7	374	96.1	p: 0.001
CMV IgG positive	148	38.5	153	39.8	83	21.6	384	99.0	χ^2 : 394.156
CMV IgG negative	2	50.0	0	0.0	2	50.0	4	1.0	p: 0.001

Toxo: *Toxoplasma*; CMV: cytomegalovirus.

performed using SPSS 11.5 (SPSS Inc.). $p < 0.05$ was considered to be statistically significant.

Table 4 summarizes the distribution of *T. gondii* IgM, *T. gondii* IgG, rubella IgM, rubella Ig G, CMV IgM, and CMV IgG according to the age groups of Syrian refugees.

Discussion

Congenital infections caused by *T. gondii*, rubella, and CMV are a significant cause of neonatal mortality and childhood morbidity worldwide. Infections by these pathogens in pregnant women can cause preterm birth, abortion, and congenital malformations. Monitoring seroprevalence of *T. gondii*, rubella, and CMV infections in women of childbearing age is important for determining prenatal screening strategies [17–19].

In our study, among the 410 Syrian refugees, 59.8% were positive for the *T. gondii* IgG antibody, while 4.4% were positive for the *T. gondii* IgM antibody. *T.*

gondii seroconversion rates vary greatly around Europe, ranging from 7% to 10% in Norway and the United Kingdom; to 44% and 50% in France and Germany, respectively [20]. In a study that included 17,751 childbearing-age women in 16 hospitals in İstanbul, Adana, Bursa, Kayseri, and Kocaeli, *T. gondii* IgM seropositivity was detected at 1.34%, and IgG seropositivity at 24.6% [21]. The prevalence of *T. gondii* in our study was relatively high compared to other studies. A possible reason for this difference in seroprevalence is that we included only Syrian refugee women who were a disadvantaged group.

In our study, 62.5% of the 56 pregnant Syrian refugees were positive for *T. gondii* IgG antibodies; 7.2% of them were positive for the *T. gondii* IgM antibodies. In a study conducted in Denizli, the seropositivity of *T. gondii* IgG was reported as 37%, and of *T. gondii* IgM was 1.4% among pregnant women [22]. Another study evaluated the *T. gondii* seroprevalence rates among pregnant Syrian refugees

Table 5. Comparison of studies evaluating rubella, *Toxoplasma* and CMV seroprevalence in literature.

Study	Study area	Study Population	Toxoplasma IgG positivity %	Toxoplasma IgM positivity %	Rubella IgG positivity %	Rubella IgM positivity %	CMV IgG positivity %	CMV IgM positivity %
Our study	Sanliurfa/ Türkiye	Syrian refugees aged 15-49 years	59.8	4.4	99.5	1.9	99.0	3.9
Kıncı et al. [40]	Muğla/ Türkiye	Local residents pregnant women	21.6	1.6	92.8	1	98.5	1.1
Efe et al. [35]	Van/ Türkiye	Local residents pregnant women	36	0.3	99.5	0.3	99.5	1.7
Akpınar et al. [31]	Isparta/ Türkiye	Local residents pregnant women			97.5	4.9	93.4	0.7
Altunal et al. [19]	İstanbul/ Türkiye	Pregnant women Turkish / Syrian	26.3 / 58.3	0.2/ 0.1	93.8/ 87.4	0 / 0	99.5/ 100	0.2 / 0
Karabulut et al. [22]	Denizli /Türkiye	Local residents pregnant women	37	1.4	95.1	0	98.7	1.2
Hansu et al. [23]	Kahramanmaraş /Türkiye	Pregnant women Turkish / Syrian	41 / 64	1.6 / 2.7				
Çelik et al. [33]	Ankara / Türkiye	Pregnant women Turkish / Syrian			93.8/ 95.9	0.5 / 0.5		
Akyar et al. [21]	İstanbul, Adana, Bursa, Kayseri, Kocaeli / Türkiye	Local residents aged 16-45 years	24.6	1.34				
Gonca et al. [26]	Mersin /Türkiye	Pregnant women Turkish / Syrian	23.3 / 51.6	04 / 1.7				
Somay et al. [27]	İzmir / Türkiye	Pregnant women Syrian refugees	51.8	4.3	78.84	0.92		

CMV: cytomegalovirus.

and pregnant Turkish women. The seropositivity rate for *T. gondii* IgM was higher among refugees than in Turkish women (2.7% and 1.6%, respectively). *T. gondii* IgG antibody positivity was 64%, in pregnant Syrian refugees, and 41% in Turkish women [23].

In a meta and modeling analysis of 250 *T. gondii* IgM and *T. gondii* IgG prevalence data including 723,655 pregnant women, the global seroprevalence of *T. gondii* IgM was 1.9%, and the global *T. gondii* IgG seroprevalence rate was 32.9%. The seroprevalence of *T. gondii* may vary between countries, depending on factors such as the dietary and hygiene habits of a population, which are particularly related to major risk factors for *T. gondii* infection. Such factors include eating raw or undercooked meat, unwashed raw vegetables or fruits, contact with cats, geographical location, mean age, and socio-economic situation [24]. A study in Kahramanmaraş compared the Syrian refugees and Turkish pregnant women in terms of *T. gondii* seroprevalence during the years 2012 and 2013. *T. gondii* IgM seropositivity were 4.76% and 4.84% in pregnant Syrian refugees and Turkish women, respectively; while *T. gondii* IgG seropositivity rates were 80% and 62.6%, respectively. *T. gondii* IgM seropositivity rates for the native people in Türkiye were 1.96% in 2012 and 2.34% in 2013, while *T. gondii* IgG seropositivity was detected at 49.7% in 2012 and 45.7% in 2013. It was reported that *T. gondii* IgM seropositivity was statistically higher in Syrian refugees [25]. In another study, Turkish pregnant women and Syrian refugee women were screened. Positive *T. gondii* IgG antibodies were detected in 23.3% Turkish women and 51.6% Syrian refugees; positive *T. gondii* IgM antibodies were detected in 0.4% and 1.7% respectively [26]. In a study in Izmir, 4.3% and 51.8% pregnant Syrian refugees were for positive *T. gondii* IgM and IgG antibodies respectively [27].

Although the rates of *T. gondii* IgG positivity in our study are generally compatible with previous studies on Syrian refugees, *T. gondii* IgM positivity was found to be higher in our study. The fact that the sample group we included in the study consisted of random women recruited after household visits rather than patients applying to the health institution may explain the difference. Our results are higher than the general seroprevalence among women with toxoplasmosis. The results may be higher due to the challenges experienced by Syrians who had to migrate due to the civil war in Syria, including the difficult housing and living conditions, and eating habits during migration.

In our study, rubella IgG seropositivity was 99.5%, and rubella IgM was 1.9%. All 56 Syrian refugee

pregnant women tested were positive for rubella IgG antibody, and 1.8% were positive for the rubella IgM antibody.

A retrospective study on reproductive-aged women reported rubella IgM seropositivity of 1.7% and rubella IgG seropositivity of 94.1% [28]. In a study in Cameroon, 91.7% of the pregnant women tested were positive for rubella IgG antibody and 1.25% were positive for the rubella IgM antibody [29]. Studies from different regions of Türkiye reported that the rubella IgM seropositivity ranged from 0.1% to 4.9%, and rubella IgG seropositivity ranged from 86.5% to 97.5% in pregnant women [22,30–32]. A study conducted in Istanbul screened pregnant Turkish and Syrian refugee women and detected rubella IgG antibodies in 93.8% and 87.4% women respectively. Rubella IgM antibodies were not detected in any patient [19]. In a retrospective study, rubella seroprevalence was compared between Syrian refugees and Turkish pregnant women. The seropositivity rate of IgG rubella antibodies in Turkish and Syrian pregnant women were 93.8% and 95.9%, respectively. Rubella IgM antibodies were detected at 0.5% in both groups [33]. In a study conducted in Izmir, positive rubella IgM and IgG antibodies were detected at 0.92% and 78.84% respectively in pregnant Syrian refugees [27].

Although the rates of rubella IgG positivity found in our study were generally compatible with studies on Syrian refugees, we detected higher rubella IgM positivity.

In our study, CMV IgG and IgM positivities were detected in 99% and 3.9% respectively. Congenital CMV infection occurs in 0.2–2.4% of all live births. The spread of CMV can cause microcephaly, chorioretinitis, and vision and hearing problems in the fetus. Seroprevalence increases with age and varies according to geographical regions and socioeconomic levels of the community [30,34].

In our study, CMV IgG antibody positivity among the 56 pregnant Syrian refugees was 98.2%, while 0% were positive for the CMV IgM antibody. In a previous study where Turkish pregnant women and Syrian refugee women were screened, CMV IgM positivity rates were 0.2% among pregnant Turkish women and 0% among pregnant Syrian refugees. However, positive CMV IgG antibodies were detected in 99.5% and 100% respectively of pregnant Turkish women and Syrian refugee women [19]. Studies on pregnant women from different regions of Türkiye have reported CMV IgM seropositivity rates between 0.4 % and 2.6 %, and CMV IgG rates between 94.9% and 100% [22,35–38]. Although our results in pregnant women were

compatible with some previous reports, the CMV IgM seropositivity rates we detected in non-pregnant women were high. High seropositivity rates might be due to poor hygienic practices, prostitution, polygamy, and the poor living conditions of the refugees.

It was determined that 175 (42.6%) of the 410 Syrian women included in our study had a pregnancy loss, miscarriage, or stillbirth. Positive *T. gondii* IgG antibody among the 175 women with pregnancy loss was 63.4%, while 5.1% were positive for the *T. gondii* IgM antibody. Rubella IgG seropositivity was 99.4%, and rubella IgM was 1.1% among these women; and CMV IgG and IgM positivities were 98.9% and 4.0% respectively. Since the data concerning pregnancy loss depends on accurate patient history, a precise result cannot be derived.

To the best of our knowledge, there are no studies in the literature on the seroprevalence of toxoplasma, rubella, and CMV in Syrian women with pregnancy loss. Our study may provide the initial data leading to future studies in this area.

When compared by age groups, *T. gondii* IgG, rubella IgG, and CMV IgG seropositivity rates were the highest in the 26–35 years age group (41.3%, 39.7%, and 39.8%, respectively) in our study. *T. gondii* IgM (44.4%) and CMV IgM (53.3%) seropositivity rate were the highest in the 15–25 years age group. Rubella IgM seropositivity rate was the highest in the 26–35 years age group (57.1%).

In a study in Istanbul, lowest *T. gondii* IgG seropositivity rates were found in the 18–25 years age group (19.4%), and the highest 36–49 years age group (26.3%); *T. gondii* IgM seropositivity rate was lowest in the 26–35 years age group (0.5%), and the same (0.8%) in the other age groups.

In another study, rubella IgM seropositivity was the highest in the 36–49 years age group (3.4%). The lowest rubella and CMV IgG seropositivity were in the 36–49 years (87.8%) and 26–35 years (98.4%) age groups [39].

In a study in Ankara, rubella IgG seropositivity rate was the highest in the 15–25 years age group (41.68%). Rubella IgG seropositivity was at 36.53% in the 26–35 years age group, and 8.33% in the 36–40 years age group. Rubella IgM seropositivity was the highest in the 15–25 years age group (2.56%). Rubella IgM seropositivity was 0.64% in the 26–25 years age group. Rubella IgM seropositivity was not detected in the 36–40 years age group [30].

In a study in Cameroon, rubella IgG positivity was more than 88% in all age groups. Rubella IgM

seropositivity was detected at 4.20% in the 18–32 years age group [29].

In our study, *T. gondii* IgG positivity was higher in the age group 26–35 years, compared to other studies. *T. gondii* IgM positivity was highest in the 15–25 years age group. This difference may be attributed to the fact that our study population consisted of Syrian refugee women and there were differences in living conditions and nutrition compared to other studies.

The population included in the study consisted of local people and rubella vaccination studies have been carried out regularly in recent years. This may be the reason why IgG positivity was higher between the ages of 15–25 years. In our study, Syrian refugee women were taken as the base and rubella IgG positivity was higher in the middle age group. Disruption of vaccination activities due to the civil war in Syria may be the reason for low positivity in the younger age group.

In our study, rubella IgM positivity was highest (57.1%) in the 26–35 years age group. IgM positivity was 42.9% in the 15–25 years age group, and not detected in the 36–45 years age group. The positivity rates in our study were generally high and this may be explained by the fact that our population consisted of Syrian refugees who were disadvantaged in terms of living conditions and vaccination.

T. gondii, rubella, and CMV are important pathogens causing perinatal infections. They may result in serious congenital abnormalities, intra-uterine growth retardation, fetal and neonatal morbidity, and mortality [40]. Seronegative women of childbearing age in the community are at risk for congenital infection. It is also essential to know the seropositivity rates of the region in order to decide whether to screen for congenital infectious agents in the antenatal period routinely [35,41]. Screening for congenital infectious agents by the ELISA method in endemic regions is crucial [31,41,42].

T. gondii seroprevalence may vary according to dietary habits, living conditions, geographical characteristics, and immune status in the community. It is important to determine the seropositivity rates of the region and to conduct screening studies. Studies conducted in our country have reported *T. gondii* IgG seropositivity rates between 24.6% and 80% [21–23,25]. In our study, the general *T. gondii* IgG seropositivity rate was 59.8% and the *T. gondii* IgG seropositivity rate in pregnant women was 62.5%. Studies conducted in our country have reported *T. gondii* IgM seropositivity rates ranging from 1.34% to 4.84% [21–23,25]. In our study, the general *T. gondii*

IgM seropositivity rate was 4.4% and the *T. gondii* IgM seropositivity rate in pregnant women was 7.2%. The low *T. gondii* IgM positivity in pregnant women suggests that they should be educated about immunization and *T. gondii* transmission routes to prevent the risk of congenital infection. Although our findings are compatible with the results of other studies in terms of *T. gondii* IgG prevalence, the *T. gondii* IgM rate was high in pregnant women.

Previous studies conducted in Türkiye reported CMV IgM seropositivity rates to vary between 0% and 2.6%, and IgG rates between 94.9% and 100% [22,35,36]. In our study, the seropositivity rates of IgG in pregnant women were comparable to other results (CMV IgG 98.2%; CMV IgM 0%), however, the CMV IgM rates we detected in non-pregnant women were higher than in other studies (CMV IgG 99%, CMV IgM 3.9%).

Pregnant women should be screened for congenital infection. Studies conducted in our country have reported rubella IgM seropositivity rates between 0% and 4.9%, and IgG rates between 86.5% and 100% [19,28,30,31]. The results of our study were generally comparable with the studies conducted on pregnant women (rubella IgG 100%, rubella IgM 1.8%). Similar results were obtained in non-pregnant women (rubella IgG 99.5%, rubella IgM 1.9%). Considering that the majority of women included in our study are immune to rubella infection, screening studies may not be necessary in the region. However, it is important to conduct regular vaccination surveys and to identify and vaccinate those who have not received regular vaccinations in childhood. Women should be informed and trained in this regard.

Table 5 presents the comparison of studies evaluating rubella, *T. gondii* and CMV seroprevalence in literature. To the best of our knowledge, there have been no studies on the seroprevalence of *T. gondii*, rubella, and CMV in Syrian women with pregnancy loss. This data is a strength of our study. The limitation of our study is that there is no data regarding vaccination of the Syrian women.

Conclusions

Based on the findings of our study we recommend that a screening program be conducted on Syrian refugees to detect rubella, *T. gondii*, and CMV infections; since the number of Syrian refugees in our province is increasing, and the living, nutritional and sanitation conditions of this population are not suitable for healthy living. Seronegative Syrian women should be vaccinated against rubella infection. In addition,

awareness programs should be organized to train the women on the transmission routes of *T. gondii* and CMV infections, and preventive measures that should be taken by women of childbearing age. The educational program should be added to primary care services.

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