

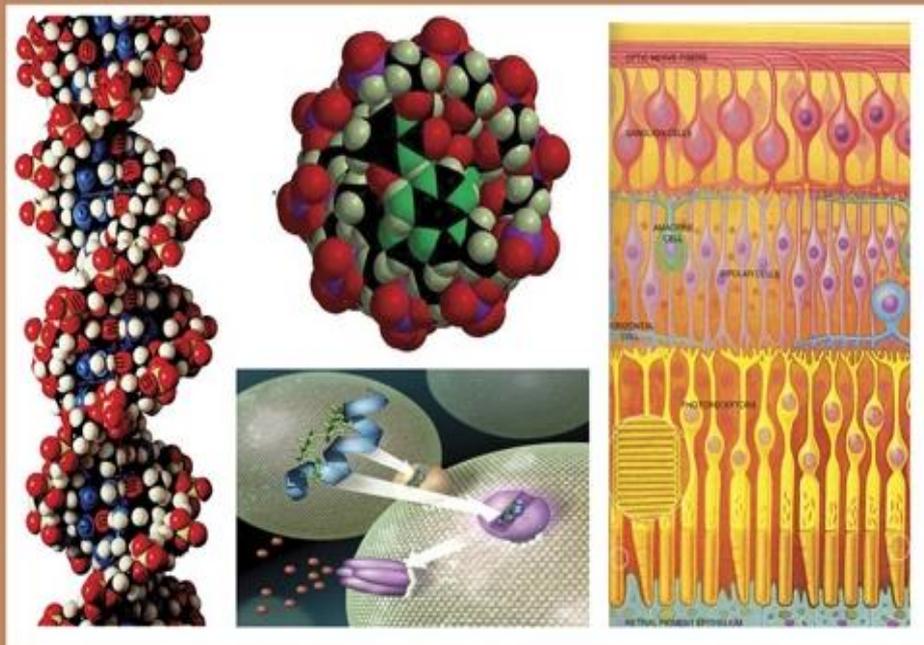


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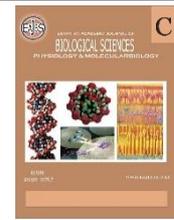
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Seroprevalence of TORCH Agents in Women with Spontaneous Miscarriage in Jizan, Saudi Arabia

Asmaa A. Hazazi¹, Yagoub H. Alhaj¹, Waled A.M. Ahmed², Raed A. Alharbi¹, Hassan J. Mahzari³, Mohammad A. Albanghali⁴, Abdulmajeed A. Sindi⁵, Osman B. Osman⁴ and Shaia S. R. Almalki^{1,*}

¹Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Al-Baha University, 65779, Saudi Arabia.

²Department of Nursing, Faculty of Applied Medical Sciences, Al-Baha University, 65779, Saudi Arabia.

³Laboratory of Al-Hurath General Hospital, Jazan, Saudi Arabia.

⁴Department of Public Health, Faculty of Applied Medical Sciences, Al-Baha University, 65779, Saudi Arabia.

⁵Department of Basic Medical Sciences, Faculty of Applied Medical Sciences, Al-Baha University, 65779, Saudi Arabia.

*E-mail: shalmalki@bu.edu.sa

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ABSTRACT

Background/Objective: Miscarriage is often a result of maternal infection with pathogens, including Toxoplasma gondii, Rubella virus, Cytomegalovirus, and Herpes Simplex Virus (TORCH). This study aimed to investigate the seroprevalence of TORCH agents in women with spontaneous miscarriage in Jizan, Kingdom of Saudi Arabia. **Methods:** A retrospective, cross-sectional study was conducted at a maternity hospital in the Jizan region. The study included 201 pregnant women who visited the hospital between 2018 and 2022. Blood samples were collected, and TORCH IgG and IgM antibodies were measured using indirect ELISA kits. Descriptive statistics and chi-square tests were used for data analysis.

Results: The majority of pregnant women fell within the 31-40 age range (49.3%) and had a graduate education level (54.2%). Among the participants, 40.3% tested positive for Toxoplasma IgG antibodies, 11.9% tested positive for Toxoplasma IgM antibodies, 24.9% tested positive for Rubella IgG antibodies, 4% tested positive for Rubella IgM antibodies, 28.9% tested positive for Cytomegalovirus IgG antibodies, and 4% tested positive for Cytomegalovirus IgM antibodies. For Herpes Simplex Virus type 1, 9% tested positive for IgG antibodies, and 0.5% tested positive for IgM antibodies. For Herpes Simplex Virus type 2, 4.2% tested positive for IgG antibodies, and 0.5% tested positive for IgM antibodies. **Conclusion:** The study revealed a significant seroprevalence of TORCH agents among women with spontaneous miscarriage in Jizan, Kingdom of Saudi Arabia. The findings highlight the importance of screening for TORCH infections during prenatal care to identify potential risks to the fetus and implement appropriate management strategies.

INTRODUCTION

Abortion, defined as a pregnancy loss occurring before 20 weeks of gestation or when the fetus weighs less than 500 g, encompasses unintended, incomplete, and missed abortions. The term "abortion" now specifically refers to surgical or medical procedures performed for therapeutic or voluntary reasons (Kortsmit *et al.*, 2020). Among the various complications affecting the fetus, infections with pathogens from the TORCH group are the most common causes (de Jong *et al.*, 2013). Primary infections with certain TORCH pathogens during pregnancy, particularly in the first trimester, are associated with an increased risk of miscarriage, stillbirth, premature birth, congenital malformations, and fetal or neonatal transient or chronic diseases (de Jong *et al.*, 2013).

TORCH infections, also known as perinatal or congenital infections, are caused by a group of organisms represented by the acronym TORCH: Toxoplasma gondii (TOX), Other (comprising parvovirus, hepatitis viruses, Epstein-Barr virus, human immunodeficiency virus, syphilis), Rubella virus (RV), Cytomegalovirus (CMV), and Herpes Simplex Virus (HSV) (Madrid *et al.*, 2016, Neu *et al.*, 2015). While the diagnosis and management of certain TORCH infections like hepatitis viruses, syphilis, and human immunodeficiency virus are clear and highly effective, others such as TOX, RV, CMV, and HSV often go unnoticed and are difficult to diagnose due to their asymptomatic nature and relatively low virulence, potentially leading to serious fetal consequences (de Jong *et al.*, 2013).

The consequences of TORCH infections during pregnancy can range from intrauterine growth restriction, and congenital malformations, to fetal death, depending on the gestational age at the time of transplacental infection (Wang *et al.*, 2019). While these infections generally cause mild illness in immunocompetent adults, they can have severe complications when acquired during pregnancy, posing

risks to the fetus and newborn. Therefore, many countries include screening tests for these infectious organisms as part of routine prenatal care to determine women's immunological status at the beginning of pregnancy (Picone *et al.*, 2020, Bobić *et al.*, 2019, Gorun *et al.*, 2020, Motoi *et al.*, 2020).

TORCH infections are vertically transmitted and contribute to significant congenital and neonatal morbidity and mortality worldwide (Liang *et al.*, 2019). The traditional TORCH infections include TOX, RV, CMV, and HSV, while the "other" category encompasses various communicable pathogens like hepatitis B and C, HIV, syphilis, Chagas disease, Zika virus, varicella, and parvovirus B19 (Warnecke *et al.*, 2020). In fact, up to 30% of stillbirths are attributed to infectious causes, although further research is needed to determine the global burden of these infections (Megli and Coyne, 2022).

The clinical outcomes of TORCH infections commonly include low birth weight, preterm birth, stillbirth, hearing and vision loss, and long-term neurological and developmental sequelae that can significantly impact affected children throughout their lives (Megli and Coyne, 2022, Warnecke *et al.*, 2020). The exact mechanisms of placental infection and vertical transmission pathways are not yet fully understood, but studies have focused on pathogen invasion of the trophoblast, decidua, maternal capillaries, or other vasculature. Therefore, this study aims to investigate the seroprevalence of TORCH agents in women with spontaneous miscarriage in Jizan, Kingdom of Saudi Arabia.

MATERIALS AND METHODS

Study Design and Setting:

This study was designed to be a retrospective and cross-sectional study. It was conducted at the maternity hospital in the Jizan region of Saudi Arabia. The study aimed to assess the frequency of TORCH infections among pregnant women in the region.

Study Population:

The study population consisted of pregnant women who visited a tertiary hospital in the Jizan region during the study period. The inclusion criteria included multigravida prenatal patients who were willing to participate. Pregnant women with a family history of congenital disorders and those with systemic ailments were excluded from the study.

Sample Size and Collection Technique:

A sample size of 201 pregnant women was collected using a convenience sampling technique. The selected participants represented a diverse group of pregnant women from the Jizan region.

Data Collection:

A retrospective analysis of medical records was performed for pregnant patients who visited a tertiary hospital in Jazan region from 2018 to 2022. Data on variables such as age, parity, Bishop Index, doses of misoprostol, and labor induction time were collected. The characteristics of TORCH screening in reproductive-age women were analyzed using logistic regression models.

Sample Collection and Laboratory Testing:

After obtaining verbal informed consent, pregnant women visiting the hospital for regular antenatal checkups provided blood samples (5–10 ml) along with clinical data. Previous pregnancy outcomes, including premature labor, low birth weight, microcephaly, intrauterine death (IUD), and congenital defects, were documented. The serum was separated through centrifugation and stored frozen. TORCH agents IgG and IgM antibodies (*T. gondii*, rubella, CMV, and HSV types 1 and 2) were estimated using commercially available indirect ELISA kits following the manufacturer's instructions.

Statistical Analysis:

The collected data, including TORCH IgG and IgM ELISA results, were coded and analyzed using SPSS Version 22 (IBM Corp., Armonk, NY, USA). Descriptive statistics were generated, and the strength of the relationship between variables was measured using appropriate statistical tests. The correlation between variables of interest was assessed using the chi-square test. A significance level of $p < 0.05$ was regarded as statistically significant at the 5% level.

RESULTS

The sociodemographic characteristics of the pregnant women ($n=201$) were revealed in Table 1. In terms of age, the majority of them fell within the 31-40 age range, comprising 49.3% of the sample, followed by the 21-30 age group at 34.8%. A smaller percentage of participants belonged to the 15-20 age group (2.5%), while those above 50 years old accounted for only 0.5%. In relation to educational level, the largest proportion of pregnant women were graduates (54.2%), with the smallest proportion as illiterate (2.5%). Examining occupation, the most common occupation reported by pregnant women was being a housewife (31.3%), while teachers accounted for 33.3%. When it comes to smoking habits in the past year, 82.1% of pregnant women reported not smoking, while 17.9% reported smoking. Additionally, the table indicates that 80.1% of participants had contact with cats during their pregnancy, while 19.9% reported no contact. Finally, the distribution of participants across different years reveals that the highest enrollment occurred in 2020 (52.7%), followed by 2019 (16.4%), 2018 (12.9%), and 2021 (17.9%).

Table 1: Sociodemographic characteristics of the study participants: (n=201).

Variable	Frequency	Percentage	
Age	15-20	5	2.5
	21-30	70	34.8
	31-40	99	49.3
	41-50	26	12.7
	>50	1	0.5
Educational level	Illiterate	5	2.5
	Elementary	33	16.4
	Secondary	54	26.9
	Graduate	109	54.2
Participants' occupation	Housewife	63	31.3
	Student	20	10
	Company	22	10.9
	Nurse	13	6.5
	Teacher	67	33.3
	Lab. technician	13	6.5
	Doctor	3	1.5
Smoking in the past year	Yes	36	82.1
	No	165	17.9
Contact to cat	Yes	161	80.1
	No	40	19.9
Year	2018	26	12.9
	2019	33	16.4
	2020	106	52.7
	2021	36	17.9

The seropositivity of TORCH (Toxoplasma, Rubella, Cytomegalovirus, Herpes) IgG and IgM antibodies among cases of miscarriage (n=201) is presented in Table 2. For Toxoplasmosis, 40.3% of the miscarriage cases tested positive for IgG antibodies, while 11.9% tested positive for IgM antibodies. In contrast, the majority of cases tested negative for both IgG (65.2%) and IgM (83.6%) antibodies. Regarding Rubella, 24.9% of cases were positive for IgG antibodies, and only 4% were positive for IgM antibodies. The majority of cases tested negative for both IgG (58.2%) and IgM (68.2%) antibodies. In terms of

Cytomegalovirus, 28.9% of cases tested positive for IgG antibodies, while 4% tested positive for IgM antibodies. The majority of cases were negative for both IgG (45.3%) and IgM (66.7%) antibodies. For Herpes 1, 9% of cases tested positive for IgG antibodies, and 0.5% tested positive for IgM antibodies. The majority of cases tested negative for both IgG (60.2%) and IgM (69.2%) antibodies. Finally, for Herpes 2, 4.2% of cases tested positive for IgG antibodies, and 0.5% tested positive for IgM antibodies. The majority of cases tested negative for both IgG (68.2%) and IgM (69.2%) antibodies.

Table 2: Seropositivity of TORCH IgG and IgM antibodies among the cases of miscarriage: (n=201).

Organism	Criteria	IgG		IgM	
		FREQ	PREC	FREQ	PREC
Toxoplasmosis	NA	7	3.5	9	4.5
	Negative	113	65.2	168	83.6
	Positive	81	40.3	24	11.9
Rubella	NA	34	16.9	56	27.9
	Negative	117	58.2	137	68.2
	Positive	50	24.9	8	4
Cytomegaly virus	NA	52	25.9	59	29.4
	Negative	91	45.3	134	66.7
	Positive	58	28.9	8	4
Herpes 1	NA	62	30.8	61	30.3
	Negative	121	60.2	139	69.2
	Positive	18	9	1	0.5
Herpes 2	NA	55	27.4	61	30.3
	Negative	137	68.2	139	69.2
	Positive	9	4.2	1	0.5

The seropositivity of TORCH (Toxoplasmosis, Rubella, Cytomegalovirus, Herpes) IgG and IgM antibodies among cases of miscarriage, categorized by year (n=201) is displayed in Table 3. For Toxoplasmosis, there was no significant difference in IgG seropositivity across the years (p=0.837), ranging from 44% to 58.8%. Similarly, IgM seropositivity did not show significant variation (p=0.867), ranging from 8.8% to 15.6%. Regarding Rubella, there were no significant differences in either IgG (p=0.951) or IgM (p=0.860) seropositivity across the years, with IgG ranging from 68.2% to 73.1% and IgM ranging from 3.6% to 9.1%. For

Cytomegalovirus, there were no significant differences in IgG (p=0.968) and IgM (p=0.499) seropositivity across the years, with IgG ranging from 60.3% to 64.3% and IgM ranging from 0% to 7.9%. In terms of Herpes 1, there were no significant differences in IgG (p=0.738) and IgM (p=0.832) seropositivity across the years, with IgG ranging from 86.3% to 92.3% and IgM ranging from 0% to 1.3%. Lastly, for Herpes 2, no significant differences were found in IgG (p=0.924) and IgM (p=0.826) seropositivity across the years, with IgG ranging from 91.7% to 96.2% and IgM ranging from 0% to 1.4%.

Table 3: Seropositivity of TORCH IgG and IgM antibodies among the cases of miscarriage per year: (n=201).

Organism	Year Criteria	IgG					P- value	IgM					P- value
		2018	2019	2020	2021	2018		2019	2020	2021			
Toxoplasmosis	Negative	14 56%	21 63.6%	60 58.8%	18 52.9%	0.837	22 88%	27 84.4%	88 87.1%	31 91.2%	0.867		
	Positive	11 44%	12 36.4%	41 41.2%	16 47.1%		3 12%	5 15.6%	13 12.9%	3 8.8%			
Rubella	Negative	16 72.7%	19 73.1%	60 68.2%	22 71%	0.951	18 94.7%	20 90.9%	72 94.7%	27 96.4%	0.860		
	Positive	6 27.3%	7 26.9%	28 31.8%	9 29%		1 5.3%	2 9.1%	4 5.3%	1 3.6%			
Cytomegaly virus	Negative	12 63.2%	14 58.3%	47 60.3%	18 64.3%	0.968	17 94.4%	20 95.2%	70 92.1%	27 100%	0.499		
	Positive	7 36.8%	10 41.7%	31 39.7%	10 35.7%		1 5.6%	1 4.8%	6 7.9%	0 0%			
Herpes 1	Negative	16 88.9%	18 81.8%	63 86.3%	24 92.3%	0.738	18 100%	21 100%	74 98.7%	26 100%	0.832		
	Positive	2 11.1%	4 18.2%	10 13.7%	2 7.7%		0 0%	0 0%	1 1.3%	0 0%			
Herpes 2	Negative	18 94.7%	22 91.7%	72 93.5%	25 96.2%	0.924	18 100%	23 100%	73 98.6%	25 100%	0.826		
	Positive	1 5.3%	2 8.3%	5 6.5%	1 3.8%		0 0%	0 0%	1 1.4%	0 0%			

Table 4 presents the seroprevalence of TORCH (Toxoplasmosis, Rubella, Cytomegalovirus, Herpes) IgG and IgM antibodies among women with abortion, categorized by age (n=201). For Toxoplasmosis, there were no significant differences in IgG seroprevalence across age groups (p=0.253), ranging from 55.9% to 62.5%. Likewise, there were no significant differences in IgM seroprevalence (p=0.655),

ranging from 9% to 16.7%. Regarding Rubella, no significant differences were observed in both IgG (p=0.120) and IgM (p=0.732) seroprevalence across age groups, with IgG ranging from 71.1% to 100% and IgM ranging from 4% to 10%. For Cytomegalovirus, there was a significant difference in IgM seroprevalence across age groups (p=0.003), ranging from 27.8% to 60%. However, there were no significant

differences in IgG seroprevalence ($p=0.760$), ranging from 38.9% to 98.1%. In terms of Herpes 1, no significant differences were found in IgG ($p=0.808$) and IgM ($p=0.792$) seroprevalence across age groups, with IgG ranging from 85.3% to 100% and IgM ranging from 85.3% to 100% and IgM ranging from 0% to 1.4%. Lastly, for Herpes 2, no significant differences were observed in IgG ($p=0.859$) and IgM ($p=0.778$) seroprevalence across age groups, with IgG ranging from 91.8% to 100% and IgM ranging from 0% to 1.5%.

Table 4: Seroprevalence of TORCH IgG and IgM antibodies among women with abortion based on women's age: (n=201).

Organism	Age Criteria	IgG					P. Value	IgM					P.value
		15-20	21-30	31-40	41-50	<50		15-20	21-30	31-40	41-50	<50	
Toxoplasmosis	Negative	5 100%	38 55.9%	55 57.3%	15 62.5%	0 0%	0.253	5 100%	61 91%	81 85.3%	20 83.3%	1 100%	0.655
	Positive	0 0%	30 44.1%	41 42.7%	9 37.5%	1 100%		0 0%	6 9%	14 14.7%	4 16.7%	0 0%	
Rubella	Negative	5 100%	41 73.2%	59 71.1%	12 54.5%	0 100%	0.120	5 100%	48 96%	66 94.3%	18 90%	0	0.732
	Positive	0 0%	15 26.8%	24 28.9%	10 45.5%	0		0 0%	2 4%	4 5.7%	2 10%	0 0%	
Cytomegaly virus	Negative	3 40%	33 61.1%	42 58.3%	13 72.2%	0 0%	0.760	3 60%	52 98.1%	62 92.5%	17 100%	0	0.003
	Positive	2 60%	21 38.9%	30 41.7%	5 27.8%	0		2 40%	1 1.9%	5 7.5%	0 0%	0 0%	
Herpes 1	Negative	5 100%	44 88%	58 85.3%	14 87.5%	0 0%	0.808	5 100%	50 100%	68 98.6%	16 100%	0	0.792
	Positive	0 0%	6 12%	10 14.7	2 12.5%	0		0 0%	0 0%	1 1.4%	0 0%	0 0%	
Herpes 2	Negative	5 100%	45 91.8%	68 94.4%	19 95%	0 0%	0.859	5 100%	49 100%	66 98.5%	19 100%	0	0.778
	Positive	0 0%	4 8.2%	4 5.6%	1 5%	0		0 0%	0 0%	1 1.5%	0 0%	0 0%	

Table 5 presents the presence of TORCH IgG antibodies and hematological parameters (Hb, PCV, and RBCs) among women with abortion (n=201). For Toxoplasmosis, there were no significant differences in the distribution of low, normal, and high levels of Hb ($p=0.252$), PCV ($p=0.012$), and RBCs ($p=0.052$) based on IgG positivity. In Rubella, there were no significant differences in the distribution of hematological parameters based on IgG

positivity. However, there was a significant association between IgG positivity for Cytomegaly virus and the distribution of low, normal, and high levels of Hb ($p=0.004$) and PCV ($p=0.011$). For Herpes 1 and Herpes 2, no significant associations were observed between IgG positivity and hematological parameters. It is important to note that the p-values indicate the level of statistical significance for the associations observed.

Table 5: TORCH IgG antibodies and hematological characters (Hb, PCV and RBCs) among women with abortion: (n=201).

Variable	IgG Result	HGB			PCV			RBCs		
		Low	Normal	High	Low	Normal	High	Low	Normal	High
Toxoplasmosis	Positive	45 38.5%	36 46.8%	0	27 57.4%	54 36.7%	0	12 66.7%	61 38.1%	8 50%
	Negative	72 61.5%	36 46.8%	0	20 42.6%	93 63.3%	0	6 33.3%	99 61.9%	8 50%
	p-value	0.252			0.012			0.052		
Rubella	Positive	25 25%	25 37.3%	0	13 32.5%	37 29.1%	0	10 66.7%	37 25.7%	3 37.5%
	Negative	75 75%	42 62.7%	0	27 67.5%	90 70.9%	0	5 33.3%	107 74.3%	5 62.5%
	p-value	0.089			0.685			0.004		
Cytomegaly virus	Positive	25 29.1%	33 52.4%	0	5 17.9%	53 43.8%	0	2 40%	52 37.4%	4 80%
	Negative	61 70.9%	30 47.6%	0	23 82.1%	68 56.2%	0	3 60%	87 62.6%	1 20%
	p-value	0.004			0.011			0.158		
Herpes 1	Positive	9 11%	9 15.8%	0	4 14.3%	14 12.6%	0	0 0%	18 14%	0 0%
	Negative	73 89%	48 84.2%	0	24 85.7%	97 87.4%	0	5 100%	111 86%	5 100%
	p-value	0.406			0.814			0.449		
Herpes 2	Positive	5 5.9%	4 6.6%	0	0 0%	9 7.6%	0	0 0%	9 6.9%	0 0%
	Negative	80 94.1%	57 93.4%	0	28 100%	109 92.4%	0	2 100%	122 93.1%	13 100%
	p-value	0.867			0.131			0.577		

The presence of TORCH IgM antibodies and hematological parameters (Hb, PCV, and RBCs) among women with abortion (n=201) is indicated in Table 6. For Toxoplasmosis, there were no significant differences in the distribution of low, normal, and high levels of Hb ($p=0.912$), PCV ($p=0.403$), and RBCs ($p=0.053$) based on IgM positivity. In Rubella, there were no significant associations between IgM

positivity and hematological parameters. Similarly, for Cytomegaly virus, no significant associations were observed between IgM positivity and hematological parameters. For Herpes 1 and Herpes 2, no significant associations were found between IgM positivity and hematological parameters. It's important to note that the p-values indicate the level of statistical significance for the observed associations.

Table 6: TORCH IgM antibodies and hematological characters (Hb, PCV and RBCs) among women with abortion: (n=201).

Variable	IgM Result	HGB			PCV			RBCs		
		Low	Normal	High	Low	Normal	High	Low	Normal	High
Toxoplasmosis	Positive	14	10		4	20		5	16	3
		12.3%	12.8		8.9%	13.6%		29.4%	10.1%	18.8%
	Negative	100	68		41	127		12	143	13
		87.7%	87.2%		91.1%	86.4%		70.6%	89.9%	81.2%
	p-value	0.912			0.403			0.053		
Rubella	Positive	5	3	0	0	8	0	0	8	0
		5.8%	5.1%		0%	7.2%		0%	6.1%	0%
	Negative	81	56	0	34	103	0	9	123	5
		94.2%	94.9%		100%	92.8%		100%	93.9%	100%
	p-value	0.850			0.107			0.636		
Cytomegaly virus	Positive	7	1	0	3	5	0	0	8	0
		8.5%	1.7%		12%	4.4%		0%	6.1%	0%
	Negative	75	59	0	22	112	0	5	124	5
		91.5%	98.3%		88%	95.7%		100%	93.9%	100%
	p-value	0.079			0.128			0.725		
Herpes 1	Positive	0	1	0	0	1	0	0	1	0
		0%	1.7%		0%	0.9%		0%	0.8%	0%
	Negative	82	57	0	28	111	0	5	128	6
		100%	98.3%		100%	99.1%		100%	99.2%	100%
	p-value	0.233			0.616			0.958		
Herpes 2	Positive	0	1		0	1		0	1	0
		0%	1.7%		0%	0.9%		0%	0.8%	0%
	Negative	82	57		25	114		2	127	10
		100%	98.3%		100%	99.1%		100%	99.2%	100%
	p-value	0.233			0.640			0.954		

The association between demographic variables and TORCH IgG status among women with abortion (n=201) revealed significant associations with gestational period and multiple gestation for certain TORCH infections (Table 7). Specifically, in the 1st trimester, a higher percentage of women tested positive for Rubella IgG compared to the negative group, while a higher percentage of women tested negative for Herpes 1 IgG compared to the positive

group. Moreover, the negative group showed a higher percentage of women with multiple gestations compared to the positive group for Cytomegaly virus IgG and Herpes 1 IgG. These findings suggest that the gestational period and multiple gestation may play a role in the development of TORCH IgG antibodies among women with abortion, emphasizing the importance of considering these factors in understanding TORCH infections.

Table 7: association between the demographic variables of participants and the TORCH IgG: (n=201).

Variables		IgG														
		Toxoplasmosis			Rubella			Cytomegaly Virus			Herpes 1			Herpes 2		
		Negative	Positive	P-value	Negative	Positive	p-value	Negative	Positive	p-value	Negative	Positive	P-value	Negative	Positive	p-value
Gestational period	1 st trimester	27 62.8%	16 37.2%	0.551	23 60.5%	15 39.5%	0.038	16 51.6%	15 48.4%	0.077	26 89.7%	3 10.3%	0.028	25 89.3%	3 10.7%	0.377
	2 nd trimester	47 54%	40 46%		50 65.8%	26 34.2%		35 55.6%	28 44.4%		53 94.6%	3 5.4%		59 96.7%	2 3.3%	
	3 rd trimester	39 69.9%	25 39.1%		44 83.0%	9 17.0%		40 72.7%	15 27.3%		42 77.8%	12 22.2%		53 93.0%	4 7.0%	
	None	48 66.7%	24 33.3%		48 82.8%	10 17.2%		28 53.8%	24 46.2%		41 82%	9 18%		53 96.4%	2 3.6%	
Number of abortions	One	41 48.8%	43 51.2%	0.106	48 63.2%	28 %	0.058	45 69.2%	20 30.8%	0.250	54 91.5%	5 8.5%	0.504	57 95%	3 5%	0.323
	Two	23 62.2%	14 37.8%		20 62.5%	12 37.5%		17 54.8%	14 45.2%		25 86.2%	4 13.8%		26 86.7%	4 13.3%	
	Three	1 100%	0 0%		1 100%	0 0%		1 100%	0 0%		1 100%	0 0%		1 100%	0 0%	
	Multiple gestation	Yes	69 56.6%		53 43.4%	.534		68 70.1%	29 29.9%		0.98	53 58.2%		38 41.8%	.374	
No	44 61.1%	28 38.9%	49 70.0%	21 30.0%	38 65.5%		20 34.5%	53 96.4%	2 3.6%	56 96.6%		2 3.4%				

DISCUSSION

The present study aimed to investigate the seroprevalence of TORCH agents (Toxoplasma, Rubella, Cytomegalovirus, and Herpes) in women with spontaneous miscarriage in Jizan, Kingdom of Saudi Arabia. The study provides valuable insights into the seroprevalence patterns and associations of TORCH infections in this specific population. To contextualize these findings, comparisons were made with previous studies to identify similarities and contrasts in seroprevalence rates and risk factors associated with TORCH infections.

Regarding the sociodemographic characteristics of pregnant women, the distribution of age groups, educational levels, occupations, and exposure to cats was consistent with previous studies (Surpam *et al.*, 2006, Prasoona *et al.*, 2015). This suggests that the sample population in this study is representative of pregnant women in terms of these demographic factors. However, it is important to acknowledge that the study's generalizability may be limited to the specific region of Jizan.

Analyzing the seropositivity of TORCH IgG and IgM antibodies among cases of miscarriage, the study found varying rates for different agents. Toxoplasma and

Rubella showed relatively higher seropositivity rates compared to Cytomegalovirus and Herpes. These findings align with previous studies, indicating consistency in seroprevalence rates across different populations (Prasoona *et al.*, 2015, Acharya *et al.*, 2014). For example, the seroprevalence rate of Toxoplasma IgG antibodies (40.3%) in this study falls within the range reported in other investigations (Paulson *et al.*, 2021). Similarly, the rates for Rubella IgG (24.9%) and Cytomegalovirus IgG (28.9%) antibodies are consistent with previous findings (Mohymen *et al.*, 2009, Adgoy *et al.*, 2020). The lower seroprevalence rates observed for Herpes 1 and Herpes 2 antibodies are also in line with existing literature (de Jong *et al.*, 2013, Wang *et al.*, 2019). Comparing the seroprevalence rates of our study with previous studies, this study provides further evidence of the global concern posed by TORCH infections during pregnancy. The findings reinforce the importance of screening and prevention strategies to mitigate the risks associated with these infections.

Despite the similarities in seroprevalence rates, some contrasting findings emerged when comparing this study with previous investigations. Notably, this

study did not find significant associations between TORCH seropositivity and age groups or gestational periods, which differs from certain previous studies (Surpam *et al.*, 2006, Wang *et al.*, 2019). These contrasting results suggest that the influence of age and gestational period on TORCH seroprevalence may vary across different populations and regions. It is important to acknowledge that this study was limited to a specific geographic area, and further research in diverse populations is necessary to obtain a more comprehensive understanding of TORCH seroprevalence and its associated factors.

Another contrasting finding was the significant associations between TORCH infections and multiple gestations observed in this study. Specifically, a higher percentage of women with multiple gestations tested positive for Cytomegalovirus and Herpes 1 IgG antibodies compared to the negative group. This contrasts with some previous studies that did not find a significant association between multiple gestations and TORCH infections (Al-Saeed *et al.*, 2015). These contrasting findings emphasize the complex nature of TORCH infections and the need for further exploration of potential risk factors.

There are several limitations of this study. Firstly, the study sample consisted of women with spontaneous miscarriages from a specific region in Saudi Arabia (Jizan), which may limit the generalizability of the results to other regions of the kingdom. Secondly, the study relied on serological testing for the detection of TORCH antibodies, which may not always accurately reflect the current infection status or the exact timing of the infections. Additionally, the study did not investigate other potential risk factors or confounding variables that could contribute to the development of TORCH infections or miscarriages.

Conclusion:

In conclusion, this study shed light on the seroprevalence of TORCH agents (Toxoplasma, Rubella, Cytomegalovirus, and Herpes) among women with

spontaneous miscarriage in Jizan, Kingdom of Saudi Arabia. The results indicate varying rates of seropositivity for different TORCH agents, with Toxoplasma and Rubella showing relatively higher seroprevalence compared to Cytomegalovirus and Herpes. These findings are consistent with previous studies conducted in different populations, highlighting the global concern associated with TORCH infections during pregnancy. Future studies with larger and more diverse populations, considering a wider range of variables and employing more comprehensive diagnostic methods, are recommended to further investigate the complexities of TORCH infections and their implications in cases of spontaneous miscarriage.

Ethical Approval: This study was commenced after acquiring approval from Jazan Health Ethics Committee, Ministry of Health (Approval number: 2303). The study was accomplished according to the guidelines of the Declaration of Helsinki. Informed consent of all participants was obtained and the identity of the participants was well protected.

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Conflict of interests: The authors declare that no conflict of interest related to this study.

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