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Silent Threat: Investigating the Prevalence of Cytomegalovirus in Expectant Mothers in Northern Iran, Gorgan

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ABSTRACT

Cytomegalovirus (CMV) infection during pregnancy is the leading cause of congenital infections worldwide, often resulting in significant health issues in newborns. These issues include sensorineural hearing loss, which can impair communication and language development, as well as neurodevelopmental delays such as cognitive impairments, motor dysfunction, and behavioral challenges. The virus can be transmitted from the mother to the fetus, particularly if the mother experiences a primary infection during pregnancy. Early detection through maternal screening and fetal diagnostic tests, such as polymerase chain reaction (PCR) analysis of amniotic fluid, is crucial. Prompt management strategies, including antiviral therapies and immunoglobulin treatments, are essential to reduce viral load and mitigate these risks, thereby improving outcomes for affected infants. In this study, vaginal secretions and blood specimens from 315 pregnant women referred to an educational hospital in northeastern Iran were tested for HCMV using PCR and ELISA (ELISA stands for Enzyme-Linked Immunosorbent Assay). Chi-Square test assessed association qualitative variables, with a significance level at $p \leq 0.05$. Statistical analysis was performed using SPSS Statistics V.26.0. The findings of the molecular and serological investigation of cytomegalovirus (CMV) in the current population revealed that 16.2% (51/315) of the individuals tested positive for DNA-CMV, 87.6% (276/315) displayed IgG antibodies, and 3.2% (10/315) showed IgM antibodies. Studying the CMV prevalence in pregnant women is crucial to understand maternal and fetal exposure to this virus, which can lead to significant congenital disabilities and developmental issues in newborns. These data are essential for developing effective screening protocols and preventive measures to reduce health risks associated with CMV infections during pregnancy.

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1. Introduction

Human herpes virus 5 (HHV-5) or Cytomegalovirus (CMV) is a leading cause of adverse sequelae as non-genetic sensorineural hearing loss (SNHL), neurodevelopmental disability and visual impairment, affecting5-15% of neonates. Additionally, 10-15 percent of congenitally infected infants show symptoms, including intrauterine growth restriction, microcephaly, hepatosplenomegaly, petechiae, jaundice, chorioretinitis, thrombocytopenia, and anemia, however, 85-90% of them are asymptomatic at the birth. Early diagnosis of asymptomatic infants with CMV is crucial, as timely intervention and follow-up can mitigate complications and disabilities caused by virus (1, 2).

CMV transmission occurs via direct contact with body fluids (such as saliva, urine, blood, cervical secretions, and semen, sexual intercourse or breastfeeding. Similar to other herpesviruses, CMV can establish latent infection and reactivate after primary infection (3). Congenital CMV infection typically results from primary maternal infection during pregnancy, particularly in the first trimester, with approximately 50% of infants born to mothers with primary CMV infection acquiring intrauterine infection. However, fewer than 5% of pregnant women with primary CMV infection exhibit symptoms, which are mostly non-specific and mild. Routine laboratory tests in pregnancy reveal only an increase in atypical lymphocytes and a slight increase in liver transaminases (4).

The global prevalence of CMV seropositivity ranges from 40-100 % (5). The overall risk of primary CMV infection during pregnancy is estimated at 0.15% and 2%, with a fetal transmission probability of 40% (5). Postnatal infection transmission via breastfeeding occurs in approximately 16.5% of premature infants. The shedding rate of the virus in breast milk among CMV-seropositive mothers is about 80.5%,andthe rate of infection in infants after consuming CMV-positive breast milk is estimated at 20.7% (6). In Iran, the immunity rate among reproductive-age women reaches approximately 90% (7). Additionally, 81.27% of pregnant women in Golestan province show positive total antibodies against CMV (5).

Given the lack of standardized pregnancy screening protocols to identify congenital CMV infection and its serious complications for the fetus, along with limited studies in Iran assessing the epidemiology of this virus in pregnant women, we decided to conduct a study to determine the molecular and serological epidemiology of CMV among pregnant women in Golestan province. The results of this research can be utilized to devise preventative measures, mitigate potential risks and establish protocols for screening and prompt interventions (8).

2. Materials and Methods

2.1. Study Population and Clinical Specimens

This research project was approved by the Ethics Committee for Human Medical Experimentation at Golestan University of Medical Sciences, Gorgan, Iran (Ethics code: IR.GOUMS.REC.1401.043). In accordance with the previously described protocol (9), the subjects of this study were obtained from pregnant women admitted to Sayyad Hospital in Northern Iran between May and September of 2018. Prior to commencing the study, approval was obtained from the participants, and an explanation of the project was provided. Moreover, they were required to complete a questionnaire covering a list of clinical, behavioral, and sociodemographic factors. In total, 315 serum and cervicovaginal lavage specimens were collected and transported on ice to the Department of microbiology at Golestan University of Medical Sciences, Gorgan, Iran. Following centrifugation of cervicovaginal lavage specimens (1000 × g for 10 min), the supernatant was discarded. Cellular materials were resuspended in 1 ml PBS and stored at -20ºC for short term storage or at –70ºC for the longer term. Peripheral blood specimens were also obtained , and aliquots of serums were obtained by centrifugation at 2000g for about 10 minutes, and then stored at −20°C until the serological analyses.

2.2. Viral DNA Extraction and Polymerase Chain Reaction

The viral DNA extraction method has been comprehensively explained in our previous study (9). The presence of UL54 (HHV-5) gene was evaluated via PCR assay using a master mix PCR kit (Amplicon, USA). The gene was amplified under the condition detailed by Yasaghi et al. (2022) (10).

2.3. Detection of CMV-Specific Antibodies

Serum IgG and IgM antibodies against CMV were detected using competitive, type-specific enzyme-linked immunosorbent assay (PT-CMV.G-96 and PT-CMV IgM-96). Results were recorded in Microsoft Excel 2019, and classified as either seropositive or seronegative based on the interpretation of the specimens.

2.4. Statistical Analysis

The analysis of clinical, behavioral, sociodemographic factors, and laboratory results was conducted using SPSS Statistics V.26.0. The Chi-Square test was employed to assess the qualitative variables, with a significance level of P values ≤0.05.

3. Results

From May to September 2018, 315 pregnant women aged 24-33 years (Table 1) were admitted to Sayyad hospital in northern Iran. Detailed demographic, behavioral ,and clinical data have been previously described (9).

The results from the molecular and serological analysis of CMV in the current population revealed 16.2% (51/315) DNA-CMV, 87.6% (276/315) IgG, and 3.2% (10/315) IgM. Table 2 provides a summary of the additional behavioral and clinical data. Accordingly, among participants who reported engaging in anal intercourse 19.6% (10/51, P= 0.4), 84.3% (43/51, P= 0.4), 2.0% (1/51, P= 0.5) CMV-DNA, IgG and IgM was detected, respectively. Additionally, only 15.6% (49/315) of the current population reported using condoms during their sexual activity, in which 24.5% (12/49, P=0.08) CMV-DNA. and 85.7% (42/49, P=0.6) CMV-IgG observed.

Almost half of the female participants in this study reported having had their first sexual experience before the age of 20 (50.4%, 159/315), during which CMV-DNA, IgG, and IgM were detected at the following rates: 15.1% (24/159, P=0.5), 88.1% (140/159, P=0.8), and 2.5% (4/159, P=0.5), respectively.The next section of the survey focused on the association of clinical factors and CMV ,with the results from the preliminary analysis ,summarized in Table 2. As indicated in this table, 9.2% (29/315), 3.5% (11/315), and 87.3% (275/315) of the participants are in their first, second and third trimester of pregnancy, respectively.

A closer look shows that the distribution of vaginal delivery (46.9%, 148/315) and cesarean section (48.2%, 152/315) are relatively even. However, it is worth noting that 4.8% (15/315) of women were referred to the hospital due to various medical conditions leading to termination of pregnancy. The most noteworthy aspect of these findings is the proportion of IgM, which is particularly striking at 4.7% (7/148), 1.3% (2/152) and 6.7% (1/15) in women who underwent vaginal delivery, cesarean section, and abortion, respectively. This result is significant at the P≤0.05 level. From the data in Table 2, it is apparent that a significant proportion of the participants, 29.8% (315/1052), had experienced an abortion. Among these individuals, 13.8% (13/94) tested positive for CMV-DNA, while 89.4% (84/94) and 4.3% (4/94) had detectable levels of IgG and IgM, respectively. The P-values associated with these findings were 0.4, 0.5, and 0.4, respectively. Further examination of clinical variables revealed that 39% (123/315) of participants exhibited unusual discharge, with the majority of these individuals testing positive for CMV-IgG (86.2%, 106/123, P=0.5). Additionally, 28.9% (91/315) of the study population reported pain during their sexual activity. Molecular and serological analysis revealed 15.4% (14/91, P=0.8) CMV-DNA and 87.6% (77/91, P=0.3), 2.2% (2/91, P=0.5) IgG and IgM in this group. In the final part of the survey, respondents were asked whether they'dundergone a Pap smear or not. Among the 315 respondents, 24.1% (76 individuals) indicated that they have got a pap smear, while 75.8% (239 individuals) reported that they have never been tested. No discernible difference was observed between the two groups.

4. Discussion

Human cytomegalovirus (HCMV) infection during pregnancy poses considerable risks to both the mother and developing fetus. HCMV is the most prevalent congenital viral infection worldwide and can lead to severe neurological, sensory, and cognitive impairments in infants, including hearing loss and developmental delay (11). Pregnant women who acquire a primary HCMV infection, particularly during the first trimester, are at the greatest risk of transmitting the virus to the fetus. However, reactivation or reinfection with HCMV during pregnancy can result in adverse outcomes (12). The precise mechanisms of vertical transmission and fetal damage are not entirely understood, but likely involve the placenta, with HCMV capable of crossing the placental barrier and directly infecting fetal tissues (13). Early detection of HCMV infection in pregnant women through serological screening and symptom monitoring is crucial for timely intervention and management strategies. These strategies may include antiviral therapy or supportive care to mitigate the risk of transmission and minimize its impact on fetal development.

Table1. Demographic data of Pregnant Women, Gorgan, Iran, May 2018 to September 2018.

	Sample Size	CMV Positive		IgG Positive		IgM Positive	
Item	N (%)	N (%)	P.value χ2	N (%)	P.value χ2	N (%)	P.value χ2
Demographic factors							
Age, y			0.9		0.4		0.6
14-23	78 (24.8%)	12 (15.4%)		69 (88.5%)		2 (2.6%)	
24-33	167 (53.0%)	27 (16.2%)		143 (85.6%)		7 (4.2%)	
34-43	70 (22.2%)	12 (17.1%)		64 (91.4%)		1 (1.4%)	
Occupation			0.5		0.8		0.5
Employee	19 (6.0%)	4 (21.1%)		17 (89.5%)		0	
Housewife	296 (94.0%)	47 (15.9%)		259 (87.5%)		10 (3.4%)	
Accommodation			0.2		0.6		0.7
Urban	172 (54.6%)	32 (18.5%)		153 (88.4%)		6 (3.5%)	
Rural	142 (45.1)	19 (13.4%)		123 (86.6%)		4 (2.8%)	
Educational Level			0.8		0.7		0.4
Illiterate	60 (19.0%)	11 (18.3%)		51 (85.0%)		2 (3.3%)	
Diploma or less	194 (61.6%)	30 (15.3%)		173 (88.3%)		8 (4.1%)	
Higher levels	59 (18.7%)	10 (16.9%)		52 (88.1%)		0	

Table2. Cytomegalovirus Molecular & serological Prevalence by Respondent Characteristics among Pregnant Women, Gorgan, Iran, May 2018 to September 2018.

	Sample Size	CMV Positive		IgG Positive		IgM Positive	
Item	N (%)	N (%)	P.value χ2	N (%)	P.value χ2	N (%)	P.value χ2
Behavioral Factors							
Anal intercourse:			0.4		0.4		0.5
Yes	51 (16.1%)	10 (19.6%)		43 (84.3%)		1 (2.0%)	
No	264(83.2%)	41 (15.5%)		233 (88.3%)		9 (3.4%)	
Condom use			0.08		0.6		0.1
Yes	49 (15.6%)	12 (24.5%)		42 (85.7%)		0	
No	264(83.8%)	39 (14.7%)		234(88.0%)		10 (3.8%)	
Age at first sexual intercourse			0.5		0.8		0.5
<20	159 (50.4%)	24 (15.1%)		140 (88.1%)		4 (2.5%)	
≥20	156 (49.5%)	27 (17.3%)		136 (87.2%)		6 (3.8%)	
Clinical Factors							
Trimester of pregnancy			0.1		0.3		0.1
1st	29 (9.2%)	1 (3.4%)		23 (79.3%)		2 (6.9%)	
2nd	11 (3.5%)	2 (18.2%)		10 (90.9%)		0	
3rd	275 (87.3%)	48 (17.5%)		243 (88.4%)		8 (2.9%)	
Mode of delivery			0.2		0.6		0.04
Vaginal	148 (46.9%)	25 (16.9%)		131 (88.5%)		7 (4.7%)	
Cesarean	152 (48.2%)	26 (17.1%)		133 (87.5%)		2 (1.3%)	
Abortion	15 (4.8%)	0		12 (80.0%)		1 (6.7%)	
History of abortion			0.4		0.5		0.4
Yes	94 (29.8%)	13 (13.8%)		84 (89.4%)		4 (4.3%)	
No	221(70.1%)	38 (17.2%)		192 (86.9%)		6 (2.7%)	
Unusual discharge			0.5		0.5		0.9
Yes	123 (39.0%)	22 (17.9%)		106 (86.2%)		4 (3.3%)	
No	192 (60.9%)	29 (15.1%)		170 (88.5%)		6 (3.1%)	
Sex pain:			0.8		0.3		0.5
Yes	91 (28.9%)	14 (15.4%)		77 (84.6%)		2 (2.2%)	
No	224 (71.1%)	37 (16.5%)		199 (88.8%)		8 (3.6%)	
Pop smear			0.8		0.1		0.2
Yes	76 (24.1%)	13 (17.1%)		63 (82.9%)		4 (5.3%)	
No	239 (75.8%)	38 (15.9%)		213 (89.1%)		6 (2.5%)	

Abbreviations: CMV: Cytomegalovirus

Furthermore, educating pregnant women about preventive measures, such as maintaining good hand hygiene and avoiding contact with bodily fluids from young children, can help reduce the incidence of HCMV infection during pregnancy (14, 15).

The present study provides valuable information on the molecular and serological prevalence of HCMV infection in women from northeast Iran, considering that a significant percentage of individuals are unacquainted with this viral infection due to its inadequate screening approach. The prevalence of these viruses is influenced by several factors, such as sample size, demographic variables (e.g., age, gender), age at coitarche, the number of lifetime sexual partners, and the diagnostic tests' specificity and sensitivity. Analysis of CMV in the current population using molecular and serological methods revealed that 16.2% (51/315) of individuals testing positive for DNA-CMV, while 87.6% (276/315) had IgG antibodies, and only 3.2% (10/315) had IgM antibodies. The molecular data in this study differ from those reported by Saravi in 2023 (16), which stands at 8%. Nevertheless, the serological data are consistent with the data documented in several publications in Iran and other countries (17, 18).

These results can be attributed to the nature of the CMV infection and immunity. CMV-IgG antibodies indicate previous exposure to the virus and long-term immunity, which is common among adults owing to the widespread prevalence of CMV. Most women of childbearing age are exposed to CMV earlier in life, leading to a high seroprevalence of CMV-IgG (19). Conversely, CMV-IgM antibodies are markers of recent primary infection or reactivation, tend to be transient and are usually present for only a few months. The detection of CMV DNA in blood or bodily fluids signifies active viral replication, which is less frequent in pregnant women because their immune systems often control the virus, leading to low viral loads detectable by DNA assays. Thus, while most pregnant women show evidence of past infection (CMV-IgG), only a small percentage have recent or active infection (CMV-IgM and CMV DNA), reflecting the dynamics of CMV immunity and reactivation (20, 21).

Regarding demographic factors, although t no significant associations were found between these factors and CMV prevalence in pregnant women, it is worth mentioning that the incidence of CMV infection in pregnant women is influenced by various sociodemographic factors, including age, education, and accommodation. Studies haveindicated that older women tend to have higher CMV seroprevalence rates than younger women, mainly because of the increased cumulative exposure to the virus over time. Moreover, lower educational attainment correlates with higher CMV prevalence in women, which may be related to socioeconomic factors that impact hygiene practices and living conditions. Furthermore, the type and quality of accommodation are critical; those living in overcrowded or substandard housing conditions are at a greater risk of CMV transmission due to closer contact with young children, who are common reservoirs of the virus. These children frequently shed the virus in their saliva and urine, facilitating household transmission. Therefore, addressing these sociodemographic factors is essential for understanding and managing CMV infection risk among pregnant women (22).

Regarding sexual behaviors, although these results found no association between engaging in anal sex, condom use ,or age at first sexual intercourse and CMV, other studies suggest that anal sex may be associated with a higher risk of CMV transmission due to the potential for mucosal damage and higher viral shedding in genital secretions, creating a more efficient route for the virus to spread (23). Condom use, on the other hand, has been shown to reduce the risk of CMV and other sexually transmitted infections by providing a barrier that limits the exchange of bodily fluids that can carry the virus (24). Additionally, an earlier age at first sexual intercourse is linked to a longer cumulative period of sexual activity and potentially more sexual partners, increasing the likelihood of CMV exposure and infection (25). Understanding these associations helps in developing targeted interventions to reduce CMV prevalence among pregnant women through sexual health education and promotion of safe sex practices.

The prevalence and impact of CMV infection in pregnant women can vary considerably depending on the stage of pregnancy and mode of delivery. In particular, primary maternal infection during the first trimester poses a high risk of transmission to the fetus with potentially severe consequences for the baby's development, due to the critical fetal development stages. Although infections during the second and third trimesters are still a concern, they generally result in less severe fetal outcomes (26).

T Mode of delivery can also affect CMV transmission, cesarean delivery could potentially reduce the risk of neonatal CMV infection compared with vaginal delivery, as it limits the newborn's exposure to maternal genital secretions that may contain the virus (27). Here, we did not find any evidence to support a relationship between the two factors and CMV prevalence in our target population. The association between abortion, history of abortion, and the prevalence of Cytomegalovirus infection in pregnant women is an important area of study. Women with a history of abortion may exhibit higher CMV seroprevalence due to increased exposure to the virus during previous pregnancies or medical procedures, which can facilitate CMV transmission. Furthermore, CMV infection during pregnancy is a known risk factor for adverse pregnancy outcomes, including spontaneous abortion, due to its ability to cause placental inflammation and impair fetal development. Several studies have shown that primary CMV infection or reactivation of latent CMV can lead to increased abortion rates, underscoring the importance of CMV screening and management in prenatal care (28).

Studying the prevalence of cytomegalovirus (CMV) among pregnant women is crucial because of its significant implications for maternal and neonatal health. CMV is the most common congenital infection worldwide and can often lead to serious outcomes such as hearing loss, developmental delays and neurodevelopmental disabilities in affected newborns. Understanding the prevalence of CMV in pregnant women helps to identify at risk population and informs public health strategies for screening and intervention. Early detection of CMV infection during pregnancy allows fortimely medical interventions, such as antiviral treatment or enhanced prenatal monitoring, aimed at mitigating adverse outcomes. Furthermore, prevalence studies can guide the development of educational programs to reduce transmission risks, such as promoting good hygiene practices and increasing awareness of CMV transmission routes. Given the substantial health burden and economic impact associated with congenital CMV infection, ongoing research is essential to improve preventive measures and optimize healthcare resources for managing this infection.

Abbreviations

WHO: World Health Organization, dsDNA: double stranded DNA, CMV: Cytomegalovirus, ELISA: Enzyme-Linked Immunosorbent Assay, PCR: Polymerase Chain Reaction.

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Authors' Contribution

Designed the study: S. DH, M. Y, A. T.
Collected specimens: S. DH, E. M, AT.
Analyzed and interpreted the data and drafted the manuscript: S. DH, A. T, E. M, H. S, A. V, M. Y.
Involved in reviewing the article: S. DH, M. Y, A. T.

Ethics

This research project was approved by the Ethics Committee for Human Medical Experimentation at Golestan University of Medical Sciences, Gorgan, Iran (Ethics code: IR.GOUMS.REC.1401.043).

Conflict of Interest

The authors report no conflict of interest in this work.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Nicloux M, Peterman L, Parodi M, Magny J-F. Outcome and management of newborns with congenital cytomegalovirus infection. Archives de Pédiatrie. 2020;27(3):160-5.
2. Gorun F, Motoi S, Malita D, Navolan DB, Nemescu D, Olariu TR, et al. Cytomegalovirus

seroprevalence in pregnant women in the western region of Romania: A large-scale study. Experimental and Therapeutic Medicine. 2020;20(3):2439-43.
3. Porobic-Jahic H, Skokic F, Ahmetagic S, Piljic D, Jahic R, Petrovic J. Cytomegalovirus infection in pregnancy-our experiences. Medical Archives. 2019;73(3):149.
4. Leruez-Ville M, Foulon I, Pass R, Ville Y. Cytomegalovirus infection during pregnancy: state of the science. American journal of obstetrics and gynecology. 2020;223(3):330-49.
5. Lakzayi E, Fozouni L, Pordeli H. A seromolecular study on the prevalence of cytomegalovirus in pregnant women living in Golestan province, Iran. Shiraz E-Medical Journal. 2020;21(7).
6. Park HW, Cho MH, Bae SH, Lee R, Kim KS. Incidence of postnatal CMV infection among breastfed preterm infants: a systematic review and meta-analysis. Journal of Korean medical science. 2021;36(12).
7. Sharghi M, Musavi H, Mansurkhani SM, Kooti W, Behzadifar M, Ashrafi-Zadeh H, et al. Seroprevalence of cytomegalovirus among women of reproductive age in iran: A systematic review and meta-analysis. Iranian journal of public health. 2019;48(2):206.
8. Beaudoin ML, Renaud C, Boucher M, Kakkar F, Gantt S, Boucoiran I. Perspectives of women on screening and prevention of CMV in pregnancy. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2021;258:409-13.
9. Hosseini SD, Yasaghi M, Mobasheri E, Nikoo HR, Tabarraei A. Molecular and Serological Epidemiology of Herpes Simplex Virus Type 1 and 2 in Pregnant Women of Gorgan City, North East of Iran. Journal of reproduction & infertility. 2023;24(1):35.
10. Yasaghi M, Hosseini SD, Moradi A, Hassanpour M, Tabarraei A. Molecular detection of HHV-1, HHV-2, HHV-5 and HBV in semen of fertile and infertile men by multiplex PCR method. Iranian Journal of Microbiology. 2022;14(6):921.
11. Mohebbi A, Mamizadeh Z, Bagheri H, Sharifnezhad F, Tabarraei A, Yazdi M. Prevalent latent human cytomegalovirus genotype b2 in biopsy samples of gastric cancer. Future Virology. 2020;15(2):71-8.
12. Sartori P, Baud D, de Tejada BM, Farin A, Rossier M-C, Rieder W, et al. Cytomegalovirus infection during pregnancy: cross-sectional survey of knowledge and prevention practices of healthcare professionals in French-speaking Switzerland. Virology journal. 2024;21(1):45.
13. Chatzakis C, Ville Y, Makrydimas G, Dinas K, Zavlanos A, Sotiriadis A. Timing of primary maternal cytomegalovirus infection and rates of vertical transmission and fetal consequences. American journal of obstetrics and gynecology. 2020;223(6):870-83. e11.
14. Hosseinzadeh Adli A, Karami C, Baghban Rahimi S, Mirarab A, Tabarraei A. What family doctors know about congenital CMV: a regional survey in Iran. Italian Journal of Pediatrics. 2018;44(1):31.
15. Tazarghi SA, Tabarraei A, Naeimi M, Moradi A, Ahmadi A, Javid N. Detection of CMV and EBV DNA in PBMCs of MS Patients and Healthy Individuals in Gorgan, Iran. مجله ویروس شناسی ایران. 32-27:(3)11;2017.
16. Saravi NM, Aghajani F, Najafi A, Khajavi R, Rahmani Z, Jalali H, et al. A seromolecular study to determine the prevalence of cytomegalovirus in pregnant women referred to health centers in the north of Iran. Iranian journal of microbiology. 2023;15(4):594.
17. Yeshwondm M, Balkachew N, Delayehu B, Mekonen G. Seroepidemiology study of cytomegalovirus and rubella among pregnant women at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia. Ethiopian Journal of Health Sciences. 2016;26(5):427-38.
18. Ghasemi FS, Rasti S, Piroozmand A, Fakhrie-Kashan Z, Mousavi SGA. Comparison of the Frequency of anti-CMV,-Rubella and-HSV antibodies in women with spontaneous abortion and normal delivery. Feyz Medical Sciences Journal. 2015;19(1):86-92.
19. Fulkerson HL, Nogalski MT, Collins-McMillen D, Yurochko AD. Overview of human cytomegalovirus pathogenesis. Human Cytomegaloviruses: Methods and Protocols. 2021:1-18.

20. Plotogea M, Isam AJ, Frincu F, Zgura A, Bacinschi X, Sandru F, et al. An overview of cytomegalovirus infection in pregnancy. Diagnostics. 2022;12(10):2429.
21. Choodinatha HK, Jeon MR, Choi BY, Lee K-N, Kim HJ, Park JY. Cytomegalovirus infection during pregnancy. Obstetrics & Gynecology Science. 2023;66(6):463-76.
22. Dana Flanders W, Lally C, Dilley A, Diaz-Decaro J. Estimated cytomegalovirus seroprevalence in the general population of the United States and Canada. Journal of Medical Virology. 2024;96(3):e29525.
23. Lourtet-Hascoet J, Mine L, Spindler L, Pilmis B, Aubert M, El Mituialy A, et al. Epidemiology of symptomatic infective anoproctitis in a population of men having sex with men (MSM). Infection. 2022;50(4):933-40.
24. Adler SP. Screening for cytomegalovirus during pregnancy. Infectious diseases in obstetrics and gynecology. 2011;2011(1):942937.
25. Manicklal S, Emery VC, Lazzarotto T, Boppana SB, Gupta RK. The “silent” global burden of congenital cytomegalovirus. Clinical microbiology reviews. 2013;26(1):86-102.
26. Balegamire SJ, Renaud C, Mâsse B, Zinszer K, Gantt S, Giguere Y, et al. Frequency, timing and risk factors for primary maternal cytomegalovirus infection during pregnancy in Quebec. PloS one. 2021;16(6):e0252309.
27. Pesch MH, Saunders NA, Abdelnabi S. Cytomegalovirus infection in pregnancy: prevention, presentation, management and neonatal outcomes. Journal of midwifery & women's health. 2021;66(3):397-402.
28. Ali SF, Al-Ahmer SD. Molecular detection of cytomegalovirus (CMV) and presence of bacterial infection in aborted women. 2020.