



Seroprevalence of Human cytomegalovirus among adult Population in Taiz city, Yemen

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Abstract

Human cytomegalovirus is a widespread herpesvirus that infects the vast majority of individuals. HCMV can establish long life latency. HCMV reactivations were reported in immunocompromised patients and pregnant females. HCMV causes congenital infections. In this study, almost 206 adults were underwent anti-HCMV IgG & IgM antibodies tests in Taiz International laboratory in Taiz city, Yemen (from March 2019 to December 2020). A total of 206 adults underwent HCMV antibodies screening tests. Among them, 12 males and 194 females. All males were HCMV IgG seropositive, while 97.9% of females were HCMV IgG seropositive. Among all patients, only four were HCMV IgM seropositive. All four HCMV IgM seropositive patients were HCMV IgG seropositive. Low socioeconomic status and poor hygiene practices determine HCMV prevalence in developing countries. Minister of Public Health, Yemen have to approve HCMV serologic test as a routine screening test for pregnant females to prevent HCMV neurological disorders in fetus/newborn.

Keywords: HCMV, Yemen, Herpesvirus, Pregnant woman, fetus, neurological disorders.

الإنتشار المصلي للفيروس المضخم للخلايا بين السكان البالغين في مدينة تعز-اليمن

الباحث/ وضاح الفقيه

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الملخص

الفيروس المضخم للخلايا هو فيروس هريس واسع الإنتشار يصيب الغالبية العظمى من الناس. الفيروس المضخم للخلايا يدخل في حالة الكمون مدى الحياة، ممكن يحصل له إعادة تنشيط خصوصا عند الأشخاص المثبتين مناعيا والنساء الحوامل. الفيروس المضخم للخلايا يسبب اصابات خلقية. في هذه الدراسة، اجريت فحوصات للأجسام المضادة للفيروس المضخم للخلايا ل 206 شخص بالغ في مختبرات تعز الدولية في مدينة تعز، اليمن (من مارس 2019م الى ديسمبر 2020م). من بين 206 شخص بالغ اجريت لهم الفحوصات كان منهم 12 رجل و 194 امرأة. كل الرجال كانت نتائجهم ايجابية لفحص الفيروس المضخم للخلايا نوع IgG بينما 97.9% من النساء كانت نتائجهم ايجابية. فقط 4 اشخاص بالغين كانت نتائج فحوصاتهم ايجابية للأجسام المضادة للفيروس المضخم للخلايا من نوع IgM من بين كل المشاركين. كل الأشخاص الذين كانت نتائجهم ايجابية للأجسام المضادة من نوع IgM كانت نتائجهم ايجابية ايضا للأجسام المضادة من نوع IgG. ضعف الحالة الإجتماعية والإقتصادية والممارسات الصحية تحدد انتشار الفيروس المضخم للخلايا في الدول النامية. لمنع إصابات الأمراض الخلقية في الأطفال حديثي الولادة على وزارة الصحة العامة في اليمن أن توفر إجراء الفحوصات المصلية الروتينية للفيروس المضخم للخلايا للنساء الحوامل.

الكلمات المفتاحية: الفيروس المضخم للخلايا، اليمن، فيروس الهريس، النساء الحوامل، الجنين، الإضطرابات العصبية.

Introduction

Human cytomegalovirus (HCMV) is a human herpesvirus. HCMV infects the vast majority of individuals (Gordon, 2018). HCMV is a member of *Herpesviridae* family. It is an enveloped virus with a double-stranded DNA (dsDNA) genome (Richman *et al.*, 2016). HCMV is associated with congenital infections. Symptoms gradually range from no signs to severe illness and sometimes lead to death as a result of a miscarriage (Şahiner,2020). HCMV infections acquire during pregnancy, during childbirth delivery, breast-feeding and, blood transfusion (Alvarado-Esquivel *et al.*, 2018).

HCMV causes a latent infection in humans that characterizes by a slow replication of the virus and can frequently reactivate in immunocompromised individuals such as cancer patients undergoing chemotherapy, human immunodeficiency virus patients, organs transplant recipients and premature infants. Immunocompromised individuals also can reinfection with new HCMV strains (Camargo & Komanduri, 2017; Louten, 2016; Razonable & Humar, 2013).

HCMV infections are transmitted mainly via horizontal or vertical routes. Infections are transmitted horizontally through person to person contact or direct contact with contaminated body fluids/secretions while vertically from infected mothers to their newborns (Richman *et al.*, 2016). In fact, transmission of HCMV during first or second trimester is associated with a higher risk of development HCMV congenital squal (Hoshino *et al.*,2009).

Anti-HCMV IgM antibodies produce after primary infection directly, while anti-HCMV IgG antibodies produce after occurrence of infection. HCMV IgM antibodies remain for three or four months, while anti-HCMV IgG antibodies remain lifelong (Šimeková *et al.*, 2019). HCMV seroprevalence in developing countries was high, particularly at adult and congenital infections of HCMV (Manicklal *et al.*, 2013). In recent years, seroprevalnce of HCMV is high that increasing morbidity and mortality in pregnant females (Naqid *et al.*, 2019). Among females seroprevalnce of HCMV is highest from males. Several studies were showed that infection was common among females practically in reproductive age (Cannon *et al.*,2010).

HCMV screening test usually does not perform as part of routine tests of pregnant females in Yemen. Few pregnant females only were screened for HCMV infection (Adler *et al.*, 2016). Diagnosis of HCMV infection mainly based on serology assays to detect anti-HCMV IgG and IgM antibodies.

Ganciclovir, valganciclovir, and cidofovir are main antiviral drugs use to inhibit of HCMV viral synthesis (Fu *et al.*, 2020). Over the past 50 years, many studies aim to develop HCMV vaccines, but there is no vaccine has been authorized yet (Schleiss *et al.*, 2017).

To our knowledge, one study only was conducted in Taiz city and showed that HCMV seroprevalence was 99% among pregnant females (Alsumairy *et al.*, 2016). The current study aims to determine the seroprevalence of HCMV infection among adult population in Taiz city from March 2019 to December 2020.

Materials and methods

Almost 206 samples were sent to Taiz International Laboratory from March 2019 to December 2020. All samples were tested for anti-HCMV IgG and IgM antibodies. Most samples were received from obstetrics and gynecology clinics. Anti-HCMV IgG and IgM antibodies tests were carried out according to standard protocol at Taiz International laboratory. Amount of 4 ml venous blood was collected from patients and poured into a sterile anticoagulant-free tube. Clotted sample was separated by centrifuge at 500 xg for 10 mins. Serum was transferred into an eppendorf tube, and stored at -20 C⁰ until examination. Serum was examined by Electro-Chemiluminescence Immunoassay technique (COBS e411) for detecting anti-HCMV IgG and HCMV IgM antibodies. Samples, controls and, calibrations were tested according to the manufacturer's instructions. Data was analyzed by using IBM SPSS statistics version 26.0.

Results

Among of 206 adult populations were tested for anti-HCMV IgM and IgG antibodies tests; 12 males and 194 females of childbearing age. All the males 12 (100%) were seropositive for anti-HCMV IgG antibodies, while 190 females (97.9%) were seropositive as shown in table 2.

Also, out of 206 tested samples for anti-HCMV IgM antibodies,

Only four (1.9%) samples were positive, while 202 (98.1%) samples were negative as shown in (Table 2). All anti-HCMV IgM antibodies positive samples were positive for anti-HCMV IgG antibodies as well.

Table.1: Seroprevalence of anti-HCMV IgG antibodies among participants.

		Negative Count (%)	Positive Count (%)	Total Count (%)	P. value
Gender	Male	0 (0 %)	12 (100%)	12 (100%)	0.785
	Female	4 (2.1%)	190 (97.9%)	194 (100%)	
Total		4	202	206	

Table.2: Seroprevalence of anti-HCMV IgM antibodies among participants.

		Negative Count (%)	Positive Count (%)	Total	P. value
Gender	Male	12 (100%)	0 (0%)	12 (100%)	0.785
	Female	190 (97.9%)	4 (2.1%)	194 (100%)	
Total		202	4	206	

Discussion

This study establishes to evaluate the seroprevalence of HCMV infections in Taiz city. There are 12 males and 194 pregnant females involve in this study. Almost 202 (98.1%) patients were anti-HCMV IgG antibodies seropositive, reflecting previous infections. All males were seropositive for anti-HCMV IgG antibodies, while only 190 (97.93%) females were seropositive.

In this study, 1.9% of females were probably susceptible to HCMV infection due to a lack of anti-HCMV IgG antibodies. This result was similar to the previous studies were conducted in Yemen; Taiz city (1%) (Alsumairy *et al.*, 2016) and Hodeidah city (1.3%), among pregnant females (Al-Arnoot *et al.*, 2020). This group has the most risk of HCMV transmission to the fetus when the infection occurs during pregnancy (Pass & Anderson, 2014). HCMV infection has different severity in the fetus according to pregnancy stages. Severe outcomes were observed when HCMV infection occurred during pregnancy at first and second trimesters (Emery & Lazzarotto, 2017).

This study showed that HCMV seroprevalence was high in adult population, particularly pregnant females. The present study showed that HCMV seroprevalence was 97.93% in pregnant females. This result was similar to published studies in Yemen: in Taiz city (99%) (Alsumairy *et al.*, 2016), Sana'a city (100%) (Edrees, 2010), and Hodeidah city (98.7%) (Alghalibi *et al.*, 2016). HCMV seroprevalence was high in some Arabic countries, such as Saudi Arabia (92.1%) (Ghazi *et al.*, 2002), Qatar (>90%) (Abu-Madi *et al.*, 2010), Iraq (100%) (AL-Jurani, 2014), Palestine (96%) (Neirukh *et al.*, 2013), Egypt (100%) (Kamel *et al.*, 2014), Tunisia (96.3%) (Hannachi *et al.*, 2011) and Sudan (97.5%) (Khairi *et al.*, 2013). Looking forward to other countries, HCMV seroprevalence was high, such as in Iran (98.8%) (Moniri *et al.*, 2015), Pakistan (97.55%) (Mujtaba *et al.*, 2016), Turkey (100%) (Parlak *et al.*, 2015), Ethiopia (88.5%) (Mamuye *et al.*, 2015), Benin (100%) (Paschale *et al.*, 2009), and Nigeria (94.8%) (Yeroh *et al.*, 2015). Comparing to this study, low HCMV seroprevalence had been reported in Ibb (68%) in pregnant females (Edrees, 2010), in Syria (74.5%) in college female students (Barah, 2012), and in Sudan (72.2%) in pregnant females (Hamdan *et al.*, 2011).

In developed countries, several studies showed that HCMV seroprevalence in pregnant females was lower than that reported in this study, such as in Japan (69.1%) (Shigemi *et al.*, 2015), Australia (57%) (Basha *et al.*, 2014), Mexico (65.6%) (Alvarado-Esquivel *et al.*, 2014), France (43.7%) (N'diaye *et al.*, 2014), England (49%) (Pembrey *et al.*, 2013), Germany (43.3%) (Enders *et al.*, 2012), Poland (62.4%) (Wujcicka *et al.*, 2014), and Belgium (30.2%) (Leuridan *et al.*, 2012).

The low HCMV seroprevalence in pregnant females of developed countries results from good hygiene practices and high socioeconomic status (Enders *et al.*, 2012; Guerra *et al.*, 2007).

In this study, only four females (1.9%) were seropositive for anti-HCMV IgM antibodies. The same result was reported in Taiz city (2%) (Alsumairy *et al.*, 2016), Turkey (1.7%) (Uyar *et al.*, 2008) and China (3.8%) (Zhang *et al.*, 2014). Moreover, this study result was lower than published results from Palestine (11.5%) (Neirukh *et al.*, 2013), Egypt (7.3%) (Kamel *et al.*, 2014), Sudan (6%) (Khairi *et al.*, 2013), and Kenya (8.1%) (Maingi & Nyamache, 2014). The existence of anti-HCMV IgM

antibodies indicate HCMV current infection or reinfection with a new strain (Šimeková *et al.*, 2019).

Most risk factors in HCMV infection is poor socioeconomic status (Bate *et al.*, 2010). HCMV seroprevalence in individuals with poor socioeconomic status was higher than that in other groups (Cannon *et al.*, 2010). In addition, HCMV seroprevalence in females was higher than that in males as a result of female's exposure to children (Cannon *et al.*, 2011).

Previous infection with HCMV cannot protect absolutely against transmission infection to fetus from mother or reinfection (Orucedil *et al.*, 2011).

Conclusion

In the current study, HCMV seroprevalence (98.1%) is very high in Taiz city, Yemen. This result is similar to other findings were reported in developing countries. The low socioeconomic status and poor hygiene practice are the main factors of high HCMV seroprevalence in developing countries compared with developed countries. Minister of Public Health and Population in Yemen have to approve HCMV serologic test as a routine screening test for all pregnant females to prevent HCMV neurological disorders in fetus/newborn.

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References

- Abu-Madi, M. A., Behnke, J. M., & Dabritz, H. A. (2010). Toxoplasma gondii seropositivity and co-infection with TORCH pathogens in high-risk patients from Qatar. *The American journal of tropical medicine and hygiene*, 82(4), 626-633.
- Adler, S. P., Manganello, A.-M., Lee, R., McVoy, M. A., Nixon, D. E., Plotkin, S., Nesterenko, P. A. (2016). A phase 1 study of 4 live, recombinant human cytomegalovirus Towne/Toledo chimera vaccines in cytomegalovirus-seronegative men. *The Journal of infectious diseases*, 214(9), 1341-1348.
- Al-Arnoot, S., Alghalibi, S. M., Abdullah, Q. Y. M., & Al-Thobhani, A. (2020). Screening for Susceptibility to Cytomegalovirus Infection Among Pregnant Women in Yemen. *J Gynecol Women's Health*, 18(3), 4.

- AL-Jurani, A. H. H. (2014). Seroprevalence of Anti-Cytomegalovirus IgM, IgG antibodies among pregnant women in Diyala province. *Diyala Journal For Pure Science*, 10(2-part 2), 116-122.
- Alghalibi, S. M., Abdullah, Q., Al-Arnoot, S., & Al-Thobhani, A. (2016). Seroprevalence of Cytomegalovirus among Pregnant Women in Hodeidah city, Yemen. *Journal of Human Virol & Retrovirol*, 3(5), 00106.
- Alsumairy, H., Alharazi, T., Alkhuleedi, S., & Alswiadi, W. (2016). Seroprevalence and risk of primary maternal HCMV infection among pregnant women in Taiz City, Yemen. *Asian Journal of Medicine and Health*, 1(1), 1-7.
- Alvarado-Esquivel, C., del Carmen Terrones-Saldivar, M., Hernandez-Tinoco, J., Munoz-Terrones, M. D. E., Gallegos-Gonzalez, R. O., Sanchez-Anguiano, L. F., Antuna-Salcido, E. I. (2018). Seroepidemiology of cytomegalovirus infection in pregnant women in the Central Mexican City of Aguascalientes. *Journal of clinical medicine research*, 10(4), 337.
- Alvarado-Esquivel, C., Hernández-Tinoco, J., Sánchez-Anguiano, L. F., Ramos-Nevárez, A., Cerrillo-Soto, S. M., Estrada-Martínez, S., Guido-Arreola, C. A. (2014). Seroepidemiology of cytomegalovirus infection in pregnant women in Durango City, Mexico. *BMC infectious diseases*, 14(1), 1-5.
- Barah, F. (2012). Prevalence of herpes simplex types 1 and 2, varicella zoster virus, cytomegalovirus, immunoglobulin G antibodies among female university students in Syria. *Saudi Med J*, 33(9), 990-994.
- Basha, J., Iwasenko, J. M., Robertson, P., Craig, M. E., & Rawlinson, W. D. (2014). Congenital cytomegalovirus infection is associated with high maternal socio-economic status and corresponding low maternal cytomegalovirus seropositivity. *Journal of paediatrics and child health*, 50(5), 368-372.
- Bate, S. L., Dollard, S. C., & Cannon, M. J. (2010). Cytomegalovirus seroprevalence in the United States: the national health and nutrition examination surveys, 1988–2004. *Clinical infectious diseases*, 50(11), 1439-1447.

- Camargo, J. F., & Komanduri, K. V. (2017). Emerging concepts in cytomegalovirus infection following hematopoietic stem cell transplantation. *Hematology/oncology and stem cell therapy*, 10(4), 233-238.
- Cannon, M. J., Hyde, T. B., & Schmid, D. S. (2011). Review of cytomegalovirus shedding in bodily fluids and relevance to congenital cytomegalovirus infection. *Reviews in medical virology*, 21(4), 240-255.
- Cannon, M. J., Schmid, D. S., & Hyde, T. B. (2010). Review of cytomegalovirus seroprevalence and demographic characteristics associated with infection. *Reviews in medical virology*, 20(4), 202-213.
- Edrees, A. (2010). *Prevalence Cytomegalovirus antibodies among pregnant women and newborns in the hospital president in Jebba, Ibb* (M.Sc. Thesis), Sana'a University, Yemen., Yemen.
- Emery, V. C., & Lazzarotto, T. (2017). Cytomegalovirus in pregnancy and the neonate. *F1000Research*, 6(138), 1-9.
- Enders, G., Daiminger, A., Lindemann, L., Knotek, F., Bäder, U., Exler, S., & Enders, M. (2012). Cytomegalovirus (CMV) seroprevalence in pregnant women, bone marrow donors and adolescents in Germany, 1996–2010. *Medical microbiology and immunology*, 201(3), 303-309.
- Fu, L., Santhanakrishnan, K., Al-Aloul, M., Jones, N., & Steeples, L. (2020). Management of ganciclovir resistant cytomegalovirus retinitis in a solid organ transplant recipient: A review of current evidence and treatment approaches. *Ocular immunology and inflammation*, 28(7), 1152-1158.
- Ghazi, H. O., Telmesani, A. M., & Mahomed, M. F. (2002). TORCH agents in pregnant Saudi women. *Medical Principles and Practice*, 11(4), 180-182.
- Gordon, C. L. (2018). T Cell Immunity To Cytomegalovirus In Health, Transplantation And Novel Vaccines. *Department of Medicine Faculty of Medicine, Dentistry and Health Sciences, Doctor of Philosophy*.
- Guerra, B., Simonazzi, G., Banfi, A., Lazzarotto, T., Farina, A., Lanari, M., & Rizzo, N. (2007). Impact of diagnostic and confirmatory tests and prenatal counseling on the rate of pregnancy termination among women with positive cytomegalovirus immunoglobulin M antibody titers. *American journal of obstetrics and gynecology*, 196(3), 221. e221-221. e226.

- Hamdan, H. Z., Abdelbagi, I. E., Nasser, N. M., & Adam, I. (2011). Seroprevalence of cytomegalovirus and rubella among pregnant women in western Sudan. *Virology journal*, 8(1), 1-4.
- Hannachi, N., Marzouk, M., Harrabi, I., Ferjani, A., Ksouri, Z., Ghannem, H., Boukadida, J. (2011). Seroprevalence of rubella virus, varicella zoster virus, cytomegalovirus and parvovirus B19 among pregnant women in the Sousse region, Tunisia. *Bulletin de la Societe de pathologie exotique (1990)*, 104(1), 62-67.
- Hoshino, Y., Pesnicak, L., Dowdell, K. C., Burbelo, P. D., Knipe, D. M., Straus, S. E., & Cohen, J. I. (2009). Protection from Herpes Simplex Virus (HSV)-2 Infection with Replication-Defective HSV-2 or Glycoprotein D2 Vaccines in HSV-1- Seropositive and HSV-1;Seronegative Guinea Pigs. *The Journal of Infectious Diseases*, 200(7), 1088-1095.
- Kamel, N., Metwally, L., Gomaa, N., Ahmed, W. S., Lotfi, M., & Younis, S. (2014). Primary cytomegalovirus infection in pregnant Egyptian women confirmed by cytomegalovirus IgG avidity testing. *Medical Principles and Practice*, 23(1), 29-33.
- Khairi, S., Intisar, K., Enan, K., Ishag, M., Baraa, A., & Ali, Y. (2013). Seroprevalence of cytomegalovirus infection among pregnant women at Omdurman Maternity Hospital, Sudan. *Journal of Medical Laboratory and Diagnosis*, 4(4), 45-49.
- Leuridan, E., Ieven, M., Hens, N., & Van Damme, P. (2012). High susceptibility to cytomegalovirus infection of pregnant women in Flanders, Belgium. *Facts, views & vision in ObGyn*, 4(2), 76.
- Louten, J. (2016). *Essential Human Virology*. United States: Elsevier Science.
- Maingi, Z., & Nyamache, A. K. (2014). Seroprevalence of Cytomegalo Virus (CMV) among pregnant women in Thika, Kenya. *BMC research notes*, 7(1), 1-5.
- Mamuye, Y., Nigatu, B., Bekele, D., Challa, F., & Desale, A. (2015). Seroprevalence and Absence of Cytomegalovirus Infection Risk Factors among Pregnant Women in St. Paul's Hospital Millennium Medical College. *Gynecol Obstet (Sunnyvale)*, 5(299), 2161-0932.1000.

- Manicklal, S., Emery, V. C., Lazzarotto, T., Boppana, S. B., & Gupta, R. K. (2013). The "silent" global burden of congenital cytomegalovirus. *Clinical microbiology reviews*, 26(1), 86-102.
doi:10.1128/CMR.00062-12
- Moniri, R., Baghbani Taheri, F., Sadat, S., & Heidarzadeh, Z. (2015). Prevalence of serum antibodies to TORCH infection in the first trimester of the pregnancy in Kashan, Iran. *Iranian Journal of Neonatology IJN*, 6(1), 8-12.
- Mujtaba, G., Shaukat, S., Angez, M., Alam, M. M., Hasan, F., Zaidi, S. S. Z., & Shah, A. A. (2016). Seroprevalence of Human Cytomegalovirus (HCMV) infection in pregnant women and outcomes of pregnancies with active infection. *JPMA*, 66(1009).
- N'diaye, D. S., Yazdanpanah, Y., Krivine, A., Andrieu, T., Rozenberg, F., Picone, O., Launay, O. (2014). Predictive factors of cytomegalovirus seropositivity among pregnant women in Paris, France. *PLoS One*, 9(2), e89857.
- Naqid, I. A., Yousif, S. H., & Hussein, N. R. (2019). Serological Study of IgG and IgM Antibodies to Cytomegalovirus and Toxoplasma Infections in Pregnant Women in Zakho City, Kurdistan Region, Iraq. *Women's Health Bulletin*, 6(4), 8-12.
- Neirukh, T., Qaisi, A., Saleh, N., Rmaileh, A. A., Zahriyeh, E. A., Qurei, L., Baraghithi, S. (2013). Seroprevalence of Cytomegalovirus among pregnant women and hospitalized children in Palestine. *BMC infectious diseases*, 13(1), 1-7.
- Orucedil, A. S., Saygan, S., & Daniman, N. (2011). Screening of cytomegalovirus seroprevalence among pregnant women in Ankara, Turkey: A controversy in prenatal care. *African Journal of Microbiology Research*, 5(29), 5304-5307.
- Parlak, M., Çim, N., Erdin, B. N., Güven, A., Bayram, Y., & Yıldızhan, R. (2015). Seroprevalence of Toxoplasma, Rubella, and Cytomegalovirus among pregnant women in Van. *Turkish journal of obstetrics and gynecology*, 12(2), 79-82.
- Paschale, M. D., Agrappi, C., Manco, M. T., Paganini, A., & Clerici, P. (2009). Incidence and risk of cytomegalovirus infection during pregnancy in an urban area of Northern Italy. *Infect Dis Obstet Gynecol*, 2009, 5. doi:10.1155/2009/206505

- Pass, R. F., & Anderson, B. (2014). Mother-to-child transmission of cytomegalovirus and prevention of congenital infection. *Journal of the Pediatric Infectious Diseases Society*, 3(suppl_1), S2-S6.
- Pembrey, L., Raynor, P., Griffiths, P., Chaytor, S., Wright, J., & Hall, A. J. (2013). Seroprevalence of cytomegalovirus, Epstein Barr virus and varicella zoster virus among pregnant women in Bradford: a cohort study. *PLoS One*, 8(11), e81881.
- Razonable, R. R., & Humar, A. (2013). Cytomegalovirus in solid organ transplantation. *Am J Transplant*, 13 Suppl 4, 93-106. [doi:10.1111/ajt.12103](https://doi.org/10.1111/ajt.12103)
- Richman, D., Whitley, R., & Hayden, F. (2016). Cytomegalovirus. In *Clinical virology* (pp. 481). ASM Press Washington, DC, USA:.
- Şahiner, F. (2020). Current Approaches in the Diagnosis and Management of Congenital Cytomegalovirus Infections and the Situation in Turkey. *Mikrobiyoloji bulteni*, 54(1), 171-190.
- Schleiss, M. R., Permar, S. R., & Plotkin, S. A. (2017). Progress toward Development of a Vaccine against Congenital Cytomegalovirus Infection. *Clinical and vaccine immunology: CVI*, 24(12), e00268-00217. [doi:10.1128/CVI.00268-17](https://doi.org/10.1128/CVI.00268-17)
- Shigemi, D., Yamaguchi, S., Otsuka, T., Kamoi, S., & Takeshita, T. (2015). Seroprevalence of cytomegalovirus IgG antibodies among pregnant women in Japan from 2009-2014. *American journal of infection control*, 43(11), 1218-1221.
- Šimeková, K., Nováková, E., Rosol'anka, R., Masná, J., & Antolová, D. (2019). Clinical course of opportunistic infections—toxoplasmosis and cytomegalovirus infection in HIV-infected patients in Slovakia. *Pathogens*, 8(4), 219.
- Uyar, Y., Balci, A., Akcali, A., & Cabar, C. (2008). Prevalence of rubella and cytomegalovirus antibodies among pregnant women in northern Turkey. *New Microbiol*, 31(4), 451-455.
- Wujcicka, W., Gaj, Z., Wilczyński, J., Sobala, W., Śpiewak, E., & Nowakowska, D. (2014). Impact of socioeconomic risk factors on the seroprevalence of cytomegalovirus infections in a cohort of pregnant Polish women between 2010 and 2011. *European Journal of Clinical Microbiology & Infectious Diseases*, 33(11), 1951-1958.

- Yeroh, M., Aminu, M., & Musa, B. (2015). Seroprevalence of cytomegalovirus infection amongst pregnant women in Kaduna state, Nigeria. *African Journal of Clinical and Experimental Microbiology*, 16(1), 37-44.
- Zhang, S., Hu, L., Chen, J., Xu, B., Zhou, Y.-H., & Hu, Y. (2014). Cytomegalovirus seroprevalence in pregnant women and association with adverse pregnancy/neonatal outcomes in Jiangsu Province, China. *PLoS One*, 9(9), e107645.