

CYTOMEGALOVIRUS ANTIBODIES AMONG PREGNANT LADIES AT KAMAL AL-SAMARRAI HOSPITAL IN BAGHDAD CITY/IRAQ

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ABSTRACT

Cytomegalovirus (CMV) infection is asymptomatic, and the essential CMV disease during pregnancy is connected with various difficulties such as intrinsic contortions, intrauterine fetal demise and later sequelae such as visual deficiency and deafness. This study aims to investigate the Frequency of human cytomegalovirus (HCMV) among pregnant women in Kamal al-Samarrai Hospital between the period August and October 2015. The cross-sectional study was done in Kamal al-Samarrai Hospital; serum was taken from pregnant patients, who were examined for cytomegalovirus IgG and IgM antibodies by enzyme linked immunosorbent measure (ELISA). Age range of selected patients was between 20 and 40 years.

A group of 132 pregnant patients was incorporated into this study, 29 of them with abortion history. **The results show that** Out of 132, 124(93.2%) were positive for IgG, 8(6.0%) were negative, 7 (5.3%) were positive for both IgG and IgM and 8 (6.0%) were negative for both antibodies. **The present results concluded that** The Frequency of CMV demonstrated high prevalence of IgG among the patients and low of IgM, thus, there is a necessity for voluntary screening to early detection of CMV infection to avoid the effects on the fetus and maternal health.

Keywords: cytomegalovirus, IgG, IgM, Kamal al-Samarrai, Pregnant Baghdad.

INTRODUCTION

Cytomegalovirus (CMV) is a double-stranded herpes DNA virus, which is transmitted by exposure to the body fluids of infected person. Cytomegalovirus transmission can occur horizontally (by direct contact, person to person with virus containing secretions such as saliva, urine, cervical secretions or semen) and vertically (mother to newborn) before, during or after birth (Jawetz, 2013, Alsumairy, 2016). Human Cytomegalovirus (HCMV) is an omnipresent (Cannon et al., 2010), Human beta herpesvirus sort 5. It belongs to the herpes virus family (herpesviridae). It causes the prototypical infection of the subfamily beta herpesvirinae (Yeroh et al., 2015).

CMV is a common inborn disease, which causes the disorder of cytomegalic consideration infection (hepatosplenomegaly, jaundice, petechial, purpura and microcephaly) (AL-Jurani et al., 2014, Lanari et al., 2006). During past-neonatal period, contaminations are asymptomatic in the immunocompetent host (Beladi et al., 2010). However, It has been reported that some of herpes virus family such as CMV can become latent (Tahani et al 2013). CMV infection initially happens in the seronegative defenseless host, and the recurrent exposure causes reactivation of idle contamination or re-infection in a seropositive invulnerable host (Brooks et al., 2007). The infection may result from initial or repetitive CMV disease. However, the repetitive CMV is the most common reason for an extreme ailment which increments with age, is higher in creating nations and among lower

financial strata of the developed countries (Hamid, 2014, Ashley, 2011).

In women with CMV reactivation during pregnancy the probability of fetal CMV transmission decreases to around 0.5% to 1.4% (Kenneson, 2007).

Frequency of CMV seropositivity was higher among populaces with lower socioeconomic and health classes (Abdolreza et al., 2010).

Essential (CMV) disease happens in 0.7% to 4.1% of pregnancies. The danger of fetal transmission is 30% to 40% in pregnancies taking after essential maternal disease, while this proportion is under than 2% after a recurrent maternal CMV infection (Yavuz, 2008).

In Iraq, serological studies have demonstrated the pervasiveness of CMV antibodies in women population to be about 85-98 % (Hussein, 2014)

Consequently, we chose to decide its commonness rate in pregnant ladies in Baghdad and its association with abortion or with individual risk factors during pregnancy (Zainab, 2013).

MATERIALS AND METHODS

A cross-sectional study conducted in Kamal al-Samarrai Teaching Hospital, Baghdad, Iraq, between August and October 2015. A total of 132 pregnant women were selected randomly, who visited the hospital for delivery. Blood samples were collected from the selected women under highly aseptic conditions. Blood samples were incubated to clot, then were centrifuged at 3000 rpm for 5 minutes. The serum was collected in sterile conta-

iners and stored at -40°C until tested. Samples were examined for IgG and IgM antibodies using ELISA test (BioCheck, Inc. foster –USA). Accordance to the manufacturer's guidelines. Absorbance was taken using 450 nm (referencing at 650 nm). List estimation of 1.2 was considered as a positive control, while file estimation of 1 was taken as negative.

Data were Statistical analysis using the computer programmed IBM SPSS version 24. According to chi-square analysis test was used to determine associations between sero prevalence and the socio variables. Significance was less than 0.05.

RESULTS

A total of 132 serum sample of pregnant women attended antenatal care in Kamal al-Samarrai Hospital. The mean of age was 29.86 ± 5.3 , with a ranged between 20 and 40 years (table 1), 124 (93.9%) of the samples were CMV IgG positive and 8(6.1%) of the samples were CMV IgG negative (table 2). While, antibodies IgM7(5.3%) were positive and 125 (94.7%)were negative. 7 ladies (5.3%) were negative for both antibodies, the CMV-IgM positive women were also CMV-IgG positive. Twenty-nine (21.96%) of the tested women had abortion history, while 103(78.03%) of women were without abortion history (table 4). Results showed high positive results among the second group and the third Group in table 2. According to chi-square analysis, there was an association of CMV IgG and IgM antibodies with ladies' with a history of abortion. Statistically there was no significant difference in the serore activity of CMV IgG and IgM antibodies among pregnant women ($p = 0.392$) & ($p = 0.156$) table 2 and 3. While there was a significant difference in the serore activity of CMV IgG, IgM antibodies with abortion history among pregnant women ($p = 0.000$) table (4).

Table 1: Distribution of ladies according to age groups

ladies age range groups / years	Numbers	%
20 - 24	26	(19.8%)
25 – 29	38	(28.7%)
30 –34	40	(30.3%)
35 - 40	28	(21.2%)
Total	132	132(100%)

Table 2: Frequency of CMV-specific IgG antibodies among different age groups of women

Age group	CMV-IgG +		CMV-IgG -		Total		p-value
	NO	%	NO	%	NO	%	
20 – 24	23	18.4	3	37.5	26	19.7	0.156
25 – 29	38	30.7	0	0	38	28.8	
30 – 34	39	31.5	1	12.5	40	30.3	
35 – 40	24	19.2	4	50	28	21.1	
Total	124	93.9	8	6.1	132	100	

Table 3. Frequency of CMV-specific IgM antibodies among different age groups of women.

Age group	CMV-IgM +		CMV-IgM -		Total		p-value
	NO	%	NO	%	NO	%	
20 – 24	2	28.6	24	19.2	26	19.7	0.156
25 – 29	1	14.3	37	29.6	38	28.8	
30 – 34	1	14.3	39	31.2	40	30.3	
35 – 40	3	42.9	25	20	28	21.2	
Total	7	5.3	125	94.7	132	100	

Table 4. Association of CMV IgG and IgM Antibodies with ladies' with history of abortion

Abortion groups	IgG with abortion history	Percentage	IgM with abortion history	Percentage	p-value
yes	28	21.2	7	5.3	0.000
No	104	78.8	125	94.7	
Total	132	100	132	100	

Discussion

The current study showed that the serofrequency of CMV among pregnant ladies was high, CMV IgG antibodies were found in (93.9%) of the sample, while (5.29%) were positive for both antibodies (IgG, IgM) and just (5.3%)were negative. This result was consistent with reports from other parts of the world including Iraq and some neighboring countries (Salih, 2013, S.M.El, 2016). Studies showed that ladies who were exposed to cytomegalovirus for the first three months of pregnancy may have a higher risk of abortion. These infections can lead to important complications on both mother and fetal health (Best, 2004, Ola et al., 2017). A few studies showed that seropositivity of CMV-IgG and IgM was high in commonality on the world, so it seems like that cytomegalovirus disease is one of the endemic diseases (Revello et al., 2002, Arabzadeh et al., 2005). Studies indicate that the results of the prevalence of the HCMV in most parts of Iraq are not very different from each other, such as Diyala (100%, 97.4%) (AL-Jurani., 2014, Mohammed, 2014), Kirkuk (98.3%) (Zainab et al., 2013), Naseriya (97.3%) (Amani. 2015), Diwanayah (59.2%) (Al-Shimmery, 2011), Baghdad (85%) (Hussein, 2014), Sulaimani (90.2%) (Salih, 2013). The Frequency of CMV IgG observed in this study was similar to the results reported in Ghana (93.2%) (Adjei, 2008), Nigeria (93.3%) (Umeh et al., 2015), Iran (94%,95%) (Abdolreza, 2010, Fere-shteh, 2017), Saudi (92.1%) (Ghazi, 2002), Cuba (92.7%) (Kouri, 2010). However, this study revealed that the incidence of CMV was high the results of developed countries such as United Kingdom(49%) (Pembrey et al., 2013), Norway (59.9%) (Alvarado, 2014), Germany (42.3%,54%)

(Enders, 2010, Lübeck, 2010), Belgium (30%) (Leuridan et al., 2012), Canada (46 %) (Sarah et al., 2016), Australia (57%) (Basha et al., 2014), Japan (69.1%) (Shigemi et al., 2015), Poland (62.4) (Wujcicka et al., 2014), Mexico (65.6%) (Alvarado et al., 2014), Italy (68.3%) (De et al., 2009), French(43.7%) (Picone et al., 2009), United States (51.2%) (Staras et al., 2006). While many developing countries revealed a higher CMV antibodies prevalence rate than this study like in some Arabic countries as in Yemen (98.7%, 99%) (Saeed et al., 2016, Yeroh et al., 2015), Brazil (97%) (Yamamoto et al., 2012), Bahrain (100%) (AlKhawaja et al., 2011), Egypt (100%) (Kamel et al., 2014), Turkey (100%) (Parlak et al., 2015), Palestine (99.6%) (Neirukh et al., 2013), Sudan (97.5 %) (Khairi et al., 2013), Iran (98.8%) (Josheghani et al., 2015), China (98.7%) (Zhang et al., 2014), Tunisia (96.3%) (Hannachi et al., 2015), Qatar (96.5%) (Abu-Madi et al., 2010). this study and other studies showed that all age groups are vulnerable to the risk of this virus. In this study, the age was not essentially connected with CMV infection, but rather the expansion in Frequency with age could be described to debilitating of the immune system with increment in age (Redwan et al., 2001).

CONCLUSION

The results obtained from this study indicated the presence of CMV IgG and IgM antibodies in high rate among pregnant women in the city of Baghdad and is likely to be transmitted from mother to fetus in the uterus through the umbilical cord or to infants. Children can also a source of infection for others. Thus, we therefore, recommend that further study is conducted to a certain the risk factors for contamination in the Baghdad. Also, routine screening of ladies of childbearing age and pregnant ladies should be considered in the health care centers. More so, pregnant ladies and ladies of childbearing age should be educated on the consequences of CMV infection and the need for them to practice good personal hygiene to reduce the risk of disease and transmission, especially hand washing after hand ling diapers or oral secretions.

REFERENCES

Abdolreza Sotoodeh Jahromi, Mahin Jamshidi Makiani, et al. Cytomegalovirus Immunity in Pregnancy in South of Iran. *Am. J. Infect. Dis.* 6(1): 8-12 (2010).

Alsumairy H., T. Alharazi, S. Alkhuleedi, et al., Seroprevalence and Risk of Primary Maternal HCMV Infection among Pregnant Women in Taiz City, Yemen, *AJMAH* 1(1): 1-7 (2016).

AL-Jurani. A., Seroprevalence of Anti- Cytomegalovirus IgM, IgG antibodies among pregnant women in Diyala province, *ISSN 10(2) 2222-8373* (2014).

Ashley L. Schoenfisch, Sheila C. Dollard, Minal Amin et al., Cytomegalovirus (CMV) shedding is highly correlated with markers of immunosuppression in CMV-seropositive women. *J. Medic. Microbiology* 60: 768–774 (2011)

Arabzadeh A.M., S.A. Mosavat et al., Seroepidemiology of Human Cytomegalovirus in Pregnant Women and their Neonates in Kerman City during 2005. *J. Kerman Univ. of Med. Sciences* 4(14): 279-288 (2007)

Amani Mahmmod Tuama, Most Common Causes of Repeated Abortion in Women in Naseriya. *M. J. B.* 12(2): (2015)

Adjei A.A., H.B. Armah, F. Gbagbo, I. Boamah, et al., Seroprevalence of Hhv-8, Cmv and Ebv among the General Population in Ghana, West Africa. *BMC infectious diseases* 8(1): 1 (2008).

Al-Shimmery M.N., H.A. Al-Hilaly, A.A. Al-Khafaji, Seroprevalence of cytomegalovirus and toxoplasmosis in cases of miscarriages women in Al-Diwaniyah province. *Al-Qadisiah Med. J.* 7: 160 (2011)

Alvarado-Esquivel C., J. Hernández-Tinoco, L.F. Sánchez-Anguiano, A. Ramos Nevárez, S.M. Cerrillo-Soto et al., Seroepidemiology of cytomegalovirus infection in pregnant women in Durango City, Mexico. *BMC Infect Dis.* 14: 484 (2014).

Alvarado-Esquivel C., J. Hernández-Tinoco, L.F. Sánchez-Anguiano, A. Ramos-Nevárez, et al., Seroepidemiology of cytomegalovirus infection in pregnant women in Durango City, Mexico. *BMC Infect. Dis.* 14: 484 (2014).

AlKhawaja S., A. Ismaeel, G. Botta, A.C. Senok, The prevalence of congenital and perinatal cytomegalovirus infections among newborns of seropositive mothers. *J. Infect. Dev. Ctries.* 6(5): 410- 415 (2011).

Abu-Madi M.A., J.M. Behnke, H.A. Dabritz, Toxoplasma gondii seropositivity and co-infection with TORCH pathogens in high-risk patients from Qatar. *Am. J. Trop. Med. Hyg.* 82 (4): 626- 633 (2010).

Beladi Mousavi S.S., F. Hayati, A. Ghorbani, Seroprevalence of Cytomegalovirus Antibody in Renal Transplant Recipients and Donors in Khuzestan Province, Iran. *Shiraz E Medical Journal* 11(4): 2010)

Best J.M., Banatvala J.E. Rubella. In: Principles and Practice of Clinical Virology. Fifth Edit-

- ion, John Wiley and Sons, Ltd., West Sussex, England 427-457 (2004).
- Basha J., J.M. Iwasenko, P. Robertson, M.F. Craig, W.D. Rawlinson, Congenital cytomegalovirus infection is associated with high maternal socio-economic status and corresponding low maternal cytomegalovirus seropositivity. *J. Paediatr Child Health* 50(5): 368-372 (2014).
- Brooks, G.F., J.S. Butel and S.A. Morse, Cytomegalovirus. In: *Medical Microbiology*. Brooks, G.F.; J.S. Butel, and M.A. Morse, 22nd Ed. McGraw-Hill Pp. 441-445 (2007)
- Cannon M.J., D.S. Schmid and T.B. Hyde, Review of cytomegalovirus seroprevalence and demographic characteristics associated with infection. *Rev. Med. Virol.* 20(4): 202-13 (2010).
- De Paschale M., C. Agrappi, M.T. Manco, A. Paganini and P. Clerici, Incidence and risk of cytomegalovirus infection during pregnancy in an urban area of Northern Italy. *Infect. Dis. Obstet. Gynecol.* 206505 (2009).
- Enders G., A. Daiminger L. Lindemann, F. Knotek et al., Cytomegalovirus (CMV) seroprevalence in pregnant women, bone marrow donors and adolescents in Germany, 1996-2010. *Med. Microbiol. Immunol.* 201(3): 303-309 (2012).
- Fereshteh Farshidi, Ghasem Abedi, Mahmood Moosazadeh, Mahdi Afshari. Seroprevalence of Cytomegalovirus Antibodies and Primary Infection among Women and Infants in Iran: A Meta-Analysis, *Iran J. Cancer. Prev.* 10(1): e3704 (2017).
- Ghazi H.O., A.M. Telmesani, M.F. Mahomed, TORCH agents in pregnant Saudi women. *Med. Princ. Pract.* 11 (4):180-2 (2002).
- Hamid K.M., A.B. Onoja, U.A. Tofa, K.N. Garba, Seroprevalence of cytomegalovirus among pregnant women attending Murtala Mohammed Specialist Hospital Kano, Nigeria. *Health Sciences* 14(3): (2014)
- Hussein A.M. Al. Baiati, Mohammed A. Muhsin, et al. Seroprevalence of Human Cytomegalovirus (HCMV) in aborted women in Baghdad province. *Int. J. Curr. Microbiol. App. Sci.* 3 (2): 97-102 (2014)
- Hannachi N., M. Marzouk, I. Harrabi, A. Ferjani, Z. Ksouri et al., Seroprevalence of rubella virus, varicella zoster virus, cytomegalovirus and parvovirus B19 among pregnant women in the Sousse region, Tunisia. *Bull. Soc. Pathol. Exot.* 104(1): 62-67 (2011).
- Jawetz E., G.F. Brooks, J. Melnick and Adelberg's. *medical microbiology*. New York: McGraw Hill Medical Pp. 470-474 (2013)
- Josheghani S.B., R. Moniri, F.B. Taheri, S. Sadat, and Z. Heidarzadeh, The Prevalence of Serum antibodies in TORCH Infections during the First Trimester of Pregnancy in Kashan, Iran. *IJN* 6: 9 (2015).
- Kenneson A. and M.J. Cannon, Review and meta-analysis of the epidemiology of congenital cyto-megalovirus (CMV) infec. *Rev. Med. Virol.* 17(4):253-76 (2007).
- Kouri, V., C. Correa, D. Verdasquera, et al., Diagnosis and screening for Cytomegalovirus infection in pregnant women in Cuba as prognostic markers of Congenital Infection Newborns: 2007-2008. *Ped. Infect. Dis. J.* 29 (12): 1105-1110 (2010).
- Kamel N., L. Metwally, N. Gomaa, A.W. Sayed, M. Lotfi, et al., Primary cytomegalovirus infection in pregnant Egyptian women confirmed by cytomegalovirus IgG avidity testing. *Med. Princ. Pract.* 23(1): 29-33 (2014).
- Khairi S., K. Intisar, K. Enan, M. Ishag, A. Baraa, et al., Seroprevalence of cytomegalovirus infection among pregnant women at Omdurman Maternity Hospital, Sudan. *J. Med. Lab. Diagn.* 4(4): 45-49 (2013).
- Lanari, M., T. Lazzarotto, V. Venturi, I. Papa, L. Gabrielli, et al., Neonatal cytomegalovirus blood load and risk of sequelae in symptomatic and asymptomatic congenitally infected newborns. *Pediatrics* 117(1): 76-83 (2006).
- Leuridan E., M. Ieven, N. Hens, P. Van Damme, High susceptibility to cytomegalovirus infection of pregnant women in Flanders, Belgium. *Facts Views Vis. Obgyn.* 4(2): 76 (2012).
- Lübeck P.R., H.W. Doerr, H.F. Rabenau, Epidemiology of human cytomegalovirus (HCMV) in an urban region of Germany: what has changed? *Med. Microbiol. Immunol.* 199: 53-60 (2010).
- Mohammed Khaleefah Khudir and Abdul-Lateef Molan. Seroprevalence of cytomegalovirus among healthy students at Diyala University, Diyala, Iraq. *IOSR-JPBS* 9(II): 59-61 (2014).
- Neirukh T., A. Qaisi, N. Saleh, A.A. Rmaileh, E. A. Zahriyeh et al., Seroprevalence of Cytomegalovirus among pregnant women and hospitalized children in Palestine. *BMC Infect. Dis.* 13: 528 (2013).
- Ola S. Abdul Jaleel, Sara A. Bakhet, et al., Sero-Detection of Cytomegalovirus and Rubella Virus IgG Antibodies Among Sudanese Pregnant Women in Khartoum State-Sudan. *AM.* 1(2): 58-64 (2017)
- Pembrey L., P. Raynor, P. Griffiths et al., Seroprevalence of cytomegalovirus, Epstein Barr virus and varicella zoster virus among preg-

- nant women in Bradford: A cohort study. *PloS one* 8(11): e81881 (2013).
- Picone O.C., F. Vauloup, A.G.I. Cordier, C. Parent Du, M.V. Senat, R. Frydman, L. Grangeot-Keros, A 2-year study on cytomegalovirus infection during pregnancy in a French hospital. *Br. J. Obstet. Gynecol.* 116 (6): 818-823 (2009).
- Parlak M., N. Çim, B.N. Erdin, A. Güven, Y. Bayram, R. Yıldızhan, Seroprevalence of Toxoplasma, Rubella, and Cytomegalovirus among pregnant women in Van. *Obstet. Gynecol.* 2: 79-82 (2015).
- Revello M.G., G. Gerna, Diagnosis and Management of Human Cytomegalovirus infection in the Mother, Fetus, and Newborn infant. *Clin. Microbiol.* 15(4): 680-715 (2002).
- Redwan N.A., M.M. Ahmedi, Prevalence study of cytomegalovirus infection among foreign manpower in Jeddah Saudi Arabia. *A. J. M. R.* 201 (2001).
- Salih Ahmed Hama and Kazhal J. Abdurahman. Human Cytomegalovirus IgG and IgM Seropositivity among Pregnant Women in Sulaimani City and Their Relations to the Abortion Rates. *Curr., Res. J. Biol. Sci.* 5(4): 161-167 (2013).
- Sarah Wizman, Valérie Lamarre, Lena Coic, Fatima Kakkar. Awareness of cytomegalovirus and risk factors for susceptibility among pregnant women, in Montreal, Canada. (2016) DOI 10.1186/s12884-016-0844-9.
- Shigemi D., S. Yamaguchi, T. Otsuka, S. Kamoi, et al., Seroprevalence of cytomegalovirus IgG antibodies among pregnant women in Japan from 2009-2014. *Am. J. Infect. Control* 43 (11): 1218-1221 (2015).
- Staras S.A.S., S.C. Dollard, K.W. Radford, W.D. Flanders, R.F. Pass, M.J. Cannon, Seroprevalence of cytomegalovirus infection in the United States, 1988-1994. *Clin. Infect. Dis.* 43(9): 1143-1151 (2006).
- Saeed M.S. Alghalibi, Qais Y.M. albdullah saad Al-Arnoot, Assem Al-Thobhani. Seroprevalence of Cytomegalovirus among Pregnant Women in Hodeidah city, Yemen. *J. Hum. Virol. Retrovirol.* 3(5): 00106 (2016)
- El-Sanousi, S.M., Z.A. Osman, et al., Cytomegalovirus infection in a cohort of pregnant women. *A.J.I.C.* 4: e41-e43 (2016)
- Tahani Neirukh, Ayda Qaisi, Niveen Saleh, et al., Seroprevalence of Cytomegalovirus among pregnant women and hospitalized children in Palestine. *BMC Infectious Diseases* 13: 528 (2013)
- Umeh E.U., T.O. Onoja, C.U. Aguoru and J.C. Umeh, Seroprevalence of Cytomegalovirus Antibodies in Pregnant Women, Benue State, Nigeria. *J. Infect. Dis. Ther.* 3: 5 (2015)
- Wujcicka W., Z. Gaj, J. Wilczyński, W. Sobala et al., Impact of socioeconomic risk factors on the Seroprevalence of cytomegalovirus infections in a cohort of pregnant Polish women between 2010 and 2011. *E.J.C.M. Infect. Dis.* 33(11): 1951-1958 (2014).
- Yeroh M., M. Aminu, B. Musa, Seroprevalence of Cytomegalovirus Infection Among pregnant women in Kaduna State, Nigeria. *JAN* 16(1); (2015)
- Yavuz Uyar, Alaaddin Balci, Alper Akcali, Cevat Cabar. Prevalence of rubella and cytomegalovirus antibodies among pregnant women in northern Turkey. *New Micro* 31: 451-455 (2008)
- Yamamoto A.Y., A.R.C. Castellucci, M.M. Mussi-Pinhata, C.M.C. Earlyhigh, Seroprevalence in pregnant women from a population with a high rate of congenital infection. *Epidemiol. Infect.* 3: 1-5 (2012).
- Zainab Khalil Mohamed Aljumaili, Abdulghani Mohamed Alsamrai, Wesam Suhail Najem. Cytomegalovirus seroprevalence in women with bad obstetric history in Kirkuk, Iraq. *J. Infec. Publ. Health* 7: 277—288 (2013).
- Zhang S., L. Hu, J. Chen, B. Xu, Y.H. Zhou, Y. Hu, Cytomegalovirus seroprevalence in pregnant women and association with adverse pregnancy/neonatal outcomes in Jiangsu Province, China. *PloS one Public Library of Science* 9(9): e107645 (2014).