RESEARCH ARTICLE

Seroprevalence of human cytomegalovirus among pregnant women who had undergone abortion(s) attending El-Damazin Hospital for Obstetrics and Gynecology, Sudan: A cross-sectional study [version 1; peer review: awaiting peer review]

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Abstract

Background: Human cytomegalovirus (HCMV) is a major cause of congenital infections. It is more widespread in developing countries and communities with low socioeconomic status. The infection can cause pregnancy loss or spontaneous abortion. Tests are available for the detection of HCMV IgG and IgM antibodies. Many pregnant women in Blue Nile State, Sudan, have suffered from recurrent pregnancy loss, and currently there is no available data concerning the prevalence of HCMV in Blue Nile state. This study aimed to determine HCMV antibodies (IgG and IgM) among pregnant women, who had undergone abortion(s), attending El-Damazin Hospital for Obstetrics and Gynecology.

Methods: This was a descriptive, cross-sectional hospital-based study. 270 pregnant women, who had undergone abortion(s) and who attended El-Damazin Hospital for Obstetrics and Gynecology, were included in the study from September to December 2018. Personal and clinical data were collected directly from each participant into a predesigned questionnaire. Serum samples were separated and stored at -20°C until used. Samples were analyzed for HCMV IgG and IgM using enzyme-linked immune-sorbent assay (ELISA).

Results: Participants were categorized into three age groups: 15-25 years (33.7%; 91/270); 26-40 years (62.2%; 168/270); and >41 years (4.1%; 11/270). The majority of the participants had IgG antibodies to HCMV (74.8%; 202/270), while only 13.3% (36/270) had IgM antibodies to HCMV. Most abortion cases were documented in the first trimester (85.6%; 231/270) and this had a significant relationship with IgG level (P=0.003). Low socioeconomic status was recorded in 84.8% (229/270) of participants.
and showed significant correlation with IgG level (P=0.025), whereas illiteracy was reported in 41.9% (113/270) of participants and did not have a significant relationship.

**Conclusions:** Seroprevalence of HCMV in this study population was 74.8% for IgG antibodies. There was an association between HCMV IgG level and first trimester abortion and low socioeconomic status among the studied women.

**Keywords**
HCMV, Abortion, IgG, First trimester, Socioeconomic, El-Damazin, Sudan.
Introduction
Cytomegalovirus (CMV) is the most ubiquitous member of the herpes virus family. Human cytomegalovirus (HCMV) is the most common cause of congenital malformation resulting from viral intrauterine infection in developed countries. CMV infects a high percentage of individuals during their life and after recovery of disease it hides in leukocytes. Although this virus is not considered as hazardous to health, in pregnant women it is a major factor that threatens the health of neonates. Primary CMV infection occurs in 0.15%-2.00% of all pregnancies and may be transmitted to the fetus in 40% of cases.

Seroprevalence of HCMV in adults ranges from 55% in developed countries to as high as over 90% in developing countries like China. In Sudan, age is significantly associated with CMV IgM detection, and history of miscarriage was associated with CMV IgG positive women. Additionally in Sudan, a study conducted in 2013 by Elamin and Omer at Khartoum Teaching Hospital reported the seroprevalence rate among pregnant women with recurrent abortion as 55.3% and 3.2% for HCMV IgG and IgM antibodies, respectively. Another recent study in Sudan conducted at Omdurman Maternity Hospital reported a sero-frequency rate of HCMV among pregnant women as 74.4% for CMV IgG and 14.4% for HCMV IgM.

HCMV can produce maternal infection and exhibits a high tropism for cervical mucosa and is considered as the most implicated virus in recurrent spontaneous abortion (RSA). Many pregnant women in Blue Nile State, Sudan, have suffered from recurrent pregnancy loss, and currently there is no available data concerning the prevalence of HCMV in Blue Nile state; therefore, this study aimed to determine HCMV antibodies (IgG and IgM) among pregnant women, who had undergone abortion(s) in this state.

Methods
Study design
This was a descriptive cross-sectional hospital-based study aimed to detect the seroprevalence of CMV among pregnant women, who had undergone RSA, attending El-Damazin Hospital for Obstetrics and Gynecology in Blue Nile State, Sudan, between March 2017 and February 2019.

Permission to carry out the study was obtained from the College of Graduate Studies, Faculty of Medical Laboratory Sciences, University of Gezira and Ministry of Health, Blue Nile State, Sudan. All women examined were informed about the purpose of the study before collection of the specimens and written consent for participation was taken.

Participants and variables
A total of 270 blood samples, taken for the purpose of this study, were collected under aseptic conditions from the participants and sera were separated in sterile containers and stored at -20°C until tested. The inclusion criterion were all pregnant women attending El-Damazin Hospital for Obstetrics and Gynecology, Sudan to undergo an abortion.

Sample size was calculated using the following formula:
$$N = \frac{(1.96)^2 (p(1-p))}{d^2}$$

Demographic and clinical data were collected directly from each woman into a predesigned questionnaire (Extended data), including personal information (age, education = illiterate), occupation, socioeconomic status (determined using household income: low, <$US$57 per month; moderate, US$57–200 per month; high, >US$200 per month), nationality, number of abortions, duration of pregnancy) and laboratory data.

The laboratory work was carried out in the Regional Public Health Laboratory and Sudanese Chinese Friendship Hospital in El-Damazin using Stat Fax microplate reader (Model: 3200) and Stat Fax washer (Model: 2600) and commercially available ELISA kits (BIOS Microwell Diagnostic System, Chemux Bioscience, Inc., USA for CMV IgM, Lot No: 18-D-055; Fortress Diagnostics Ltd, UK for CMV IgG Lot No: CG-1807-1). Positive and negative results for IgG and IgM were recorded according to calculated cut-off values. For CMV IgG, the cut-off value was obtained by subtracting the blank absorbance from the mean absorbance of calibrator 2.

For CMV IgM the cut-off value was obtained by multiplying the optical density (OD) of the calibrator by factor (F) printed on label of calibrator. CMV IgM index for each sample obtained by dividing OD of sample over the cut-off.

Data analysis
Data analysis was done using Statistical Package for Social Sciences (SPSS version 24; IBM SPSS). Pearson Chi-squared test was used to test for statistical significance (P value), which was taken as significant when p < 0.05.

Results
A total of 270 women were enrolled in the study. The majority of the women were aged between 26 and 40 years. Low socioeconomic status was recorded in 84.8% (229/270) of participants, and illiteracy and women obtaining primary education was observed in 80% of participants. Most women were observed to be in the first trimester of pregnancy (85.5%; 231/270) (Table 1). In total, 27.8% (75/270) of the women had a history for 1-7 abortions, while 72.2% (195/270) had no history.

The seroprevalence of HCMV IgG and IgM among the 270 women was 74.8% (202/270) and 13.3% (36/270), respectively (Figure 1).

HCMV IgG detection was significantly correlated to socioeconomic status and gestation stage, but was not correlated to age group and education level (Table 2).

Discussion
CMV is globally distributed, with 40–100% of the global population positive for CMV antibodies, particularly among low economic individuals. In Sudan, there are only a few published data (Western and Central Sudan, and Khartoum) concerning epidemiology of HCMV among pregnant women.
Table 1. Demographic data of pregnant women who had spontaneous abortion in Sudan between September and December 2018.

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age groups</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15– 25 years</td>
<td>91</td>
<td>33.7</td>
</tr>
<tr>
<td>26–40 years</td>
<td>168</td>
<td>62.2</td>
</tr>
<tr>
<td>&gt;41 years</td>
<td>11</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Socioeconomic status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income</td>
<td>229</td>
<td>84.8</td>
</tr>
<tr>
<td>Moderate income</td>
<td>41</td>
<td>15.2</td>
</tr>
<tr>
<td><strong>Gestation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st trimester</td>
<td>231</td>
<td>85.5</td>
</tr>
<tr>
<td>2nd trimester</td>
<td>38</td>
<td>14.1</td>
</tr>
<tr>
<td>3rd trimester</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>113</td>
<td>41.9</td>
</tr>
<tr>
<td>Basic</td>
<td>98</td>
<td>36.2</td>
</tr>
<tr>
<td>Primary</td>
<td>5</td>
<td>1.9</td>
</tr>
<tr>
<td>Secondary</td>
<td>31</td>
<td>11.5</td>
</tr>
<tr>
<td>University</td>
<td>23</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>270</td>
<td>100</td>
</tr>
</tbody>
</table>

In our study area, which it located in the South of Sudan, there are no findings about the seroprevalence of HCMV in pregnant women who have had abortions.

The relationship between seroprevalence of HCMV and socioeconomic and education level among the present study population is significant, which may explain poor health status and susceptibility to certain diseases. Numerous studies have evaluated socioeconomic and education level for seroprevalence of HCMV, and most of these studies confirm the strong association between the socioeconomic disparities and high seropositivity\[13\].

HCMV IgG level in this study was significantly correlated to abortion in the 1st trimester gestation, which has also been shown by other studies\[14\]. HCMV infection is considered a significant public health problem because it can cause disease in those with weakened immune systems, which has been confirmed by a study in Sudan in which a high frequency (98.3%) of seroprevalence of HCMV among pregnant women was reported\[19\].

In the present study, the sero-prevalence of HCMV among the participants was 74.8% for IgG and 13.3% for IgM; these findings are in total agreement with another study in Sudan among

Figure 1. Sero-prevalence of HCMV IgG and IgM among 270 aborted pregnant women.
pregnant women, but is in contrast to other study in Iran in which the frequency for HCMV IgG and IgM was 14.28% and 28.25%, respectively\(^2\). Larger and smaller frequencies of HCMV IgG level have also been reported in Egypt\(^2\) and Iran\(^2\), respectively. The IgM level found in this study is similar to findings reported in Poland (13%) by Fowler and Boppana\(^2\), and similar results were obtained by other authors in Iraq\(^2\) and India\(^2\). Higher results have been reported in Egypt (32.6%) for HCMV IgM, and lower results have been reported in Turkey\(^2\) and Korea\(^2\) (1% and 1.7%, respectively). Many factors may contribute to HCMV transmission and prevalence, such as socioeconomic and lifestyle factors, and it should be noted that most immunocompetent carriers of HCMV remain asymptomatic\(^2\).

In this study, 11.9% of the study population revealed primary infection with HCMV, i.e. positive results for both IgG and IgM. This frequency is larger than that recorded previously in a hospital in Khartoum\(^2\).

Table 2. Correlation of positive HCMV IgG status with socioeconomic status, gestation, age group and education level in Sudanese women who had undergone spontaneous abortion in the time period September–December 2018 (n=202).

<table>
<thead>
<tr>
<th>Socioeconomic status</th>
<th>N (%)</th>
<th>Chi squared</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>82.2 (166)</td>
<td>4.329</td>
<td>0.025</td>
</tr>
<tr>
<td>Moderate</td>
<td>17.8 (36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st trimester</td>
<td>89.6 (181)</td>
<td>11.797</td>
<td>0.003</td>
</tr>
<tr>
<td>2nd trimester</td>
<td>9.9 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd trimester</td>
<td>0.5 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15–25 years</td>
<td>34.6 (20)</td>
<td>0.729</td>
<td>0.694</td>
</tr>
<tr>
<td>26–40 years</td>
<td>60.9 (123)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;41 years</td>
<td>4.5 (9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>43.1 (87)</td>
<td>2.601</td>
<td>0.627</td>
</tr>
<tr>
<td>Basic</td>
<td>35.1 (71)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>2.5 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>11.4 (23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>7.9 (16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions
Seroprevalence of HCMV in Blue Nile State, Sudan, among pregnant women who had undergone abortion(s) was 74.8% for IgG and 13.3% for IgM. HCMV prevalence in pregnant women was most prevalent for women in the first trimester with low economic status.

Data availability
Underlying data
Figshare: HCMV seroprevalence, Blue Nile State, Sudan, https://doi.org/10.6084/m9.figshare.9895715.v1\(^3\)

This project contains the following underlying data:
- ELISA antibody titre data
- Demographic and clinical data for participants

Extended data
Figshare: HCMV seroprevalence, Blue Nile State, Sudan, https://doi.org/10.6084/m9.figshare.9895715.v1\(^3\)

This project contains the following extended data:
- Questionnaire in English.

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

References
7. Mohammed NSAEH, Elhag WI: Serofrequency of Cytomegalovirus among pregnant ladies attending antenatal care at Omdurman Maternity Hospital,


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