https://doi.org/10.54361/ajmas.269106

Original article

Recent Insights into Cytomegalovirus Serostatus among Pregnant Women in Tripoli, Libya

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Abstract
Cytomegalovirus (CMV) is a common viral infection that frequently impacts pregnant women globally and causes congenital infections. During pregnancy, primary or recent CMV infection may result in congenital malformations. Although certain Libyan studies have been published on maternal CMV infection, comprehensive data on its seroprevalence during pregnancy remain insufficient. Thus, this study aims to explore the current status of the seroprevalence and examine factors associated with CMV infection among Libyan pregnant women. A cross-sectional study was conducted from September to December 2025, recruiting 202 pregnant women aged 18-47 years who attended antenatal clinics in Tripoli, Libya. Out of 202 pregnant women, 75 were subjected to a concise questionnaire. Venous blood samples were collected, and serum was analyzed. CMV-specific IgG and IgM antibodies were detected using Electrochemiluminescence Immunoassay (ECLIA) on the Roche Cobas e 411 analyzer. Data were analyzed using Python software, and results were expressed as frequencies, percentages, and geometric mean titres (GMTs) with 95% confidence intervals (95% CI). The overall seroprevalence of CMV IgG was 64.85%, while the seropositivity rate for IgM was 27.23%. High IgG seropositivity was observed across all age groups, whereas IgM positivity varied, with the highest rate observed among women aged 30–34 years. Furthermore, we showed that both the first and second trimesters exhibited an increase in the IgG seroprevalence compared to the third trimester. Likewise, women residing in rural areas and those from larger households demonstrated higher CMV IgG levels. Miscarriage history showed minimal association with CMV antibody levels. There is a high prevalence of CMV infection among pregnant women in Tripoli, with most cases reflecting past exposure rather than recent infection. Our findings indicate a high level of immunity to CMV among Libyan pregnant women. Antibodies distribution was influenced by age, gestational period, residence, and family size, while miscarriage history had a limited effect. Our findings urgently call for early screening of CMV during pregnancy, along with increased awareness of preventive hygiene practices and the establishment of local guidelines aimed at reducing the risks of maternal and congenital infections.
Keywords. Cytomegalovirus, Congenital Infection, Pregnant Women, Seroprevalence, Serostatus.

Introduction

CMV or Human Herpesvirus 5 (HHV-5) is a member of the *Herpesviridae* family and is classified within the *Betaherpesvirinae* subfamily, which also includes HHV-6 and HHV-7 [1,2]. CMV is an enveloped virus containing a double-stranded DNA genome and a capsid composed of approximately 162 capsomers [3,4]. Unfortunately, the virus is capable of establishing lifelong latency, practically within cells of myeloid lineage, with reactivation occurring under immunosuppression conditions [5]. Globally, CMV is recognized as the most frequently encountered congenital viral infection, affecting an estimated 0.5–2.5% of newborns annually [6]. In fact, primary maternal infection during pregnancy presents the greatest risk for congenital transmission and can significantly and progressively impact fetal development [7]. Exposure to various bodily fluids, including blood, semen, vaginal secretions, saliva, tears, urine, fecal matter, and breast milk, can indeed allow the infection to be transmitted [8]. Pregnant individuals most often acquire the virus through sexual contact or through close, everyday interactions with young children, particularly those who attend daycare [9].

In immunocompetent individuals, CMV infection is usually asymptomatic or manifests as a mild mononucleosis-like illness with fatigue, fever, or myalgia [4,10]. In contrast, immunocompromised individuals such as transplant recipients, HIV-positive patients, and developing fetuses may experience severe illness, including organ-specific involvements such as hepatitis, pneumonitis, retinitis, gastrointestinal injury, or multisystem diseases [11]. On the other hand, congenital CMV infection may result in several unpleasant medical conditions, including growth restriction, hepatosplenomegaly, jaundice, rash, and a small head (microcephaly). Some infants may experience long-term problems like hearing loss, vision loss, and developmental delays [12].

Accurate diagnosis in pregnant women is essential for identifying both prior exposure and recent infection. Serological testing for CMV-specific IgG and IgM antibodies remains the principal diagnostic approach until now [13]. IgG generally reflects the past infection, whereas IgM may appear during primary infection, reinfection, or even reactivation [14, 15]. To date, maternal serological testing remains the first line of protection in identifying a woman's immune status. In developing countries, this approach continues to be commonly used because of its high sensitivity, reliability, and capability in evaluating maternal infection status and assessing the potential risk of fetal transmission [16]. Different algorithms for monitoring maternal CMV infection have been developed and proposed, but none have ever been officially established

Received: *02-11-2025* - ***Accepted***: *29-12-2025* - ***Published***: *06-01-2026*

in any healthcare setting [16]. On the other hand, ongoing research in antiviral therapies and vaccine development, including the investigation of agents like maribavir, suggests potential avenues for future prevention strategies against CMV [17]. However, there is currently no widely approved CMV vaccine available, and further studies are necessary to establish safe and effective immunization methods for pregnant women and newborns [18]. Until such tools are available, early diagnosis, public awareness, and adherence to preventative practices remain the most effective approaches for reducing CMV-related complications, particularly among high-risk populations [10, 12].

Global seroprevalence studies demonstrate that CMV exposure is common among pregnant women. In a more recent study conducted by Katungye *et al*, 2025, it was found that the seroprevalence of CMV IgG was found to be universal (100%) among the 637 women [19]. Furthermore, a study from Sudan conducted between February 2018 to January 2020 reported IgG seropositivity of 92.4% and IgM positivity of 31.2% among pregnant women [20]. In addition, in South West Romania, IgG seroprevalence increased from 93.68% (2013-2016) to 94.96% (2019-2022), while IgM positivity rose slightly from 1.92% to 2.26% [21]. Meanwhile, data from Zliten city, Libya, revealed extensive prior exposure, with 94% IgG positivity and a comparatively lower 6% IgM prevalence, suggesting limited recent infection [22]. Recently, in Tripoli city of Libya, a high seroprevalence (95.8%) of CMV IgG was found among the 97 women, suggesting an urgent call for an awareness program regarding human CMV infection [23].

Public health interventions aimed at reducing congenital CMV infections in women of childbearing age focus on raising awareness and decreasing transmission risks. This includes promoting hygiene practices to lower the likelihood of infection and, when applicable, offering early screening and treatment to avert primary infections and protect the fetus [24]. Basically, healthcare providers must enhance women's understanding of CMV by creating culturally appropriate communication techniques to inform pregnant women, encouraging adherence, increasing awareness of preventive measures, and improving the management of CMV infections [25, 26, 27]. Despite the global prevalence of CMV, comprehensive epidemiological data on Libyan maternal CMV to estimate disease burden are still obscure in Libya. There is a necessity for applying an early screening during preconception and early pregnancy for identifying at-risk women and attenuating congenital CMV transmission [18, 20]. This study aims to explore the seroprevalence of CMV-specific IgG and IgM antibodies among pregnant women attending antenatal clinics in Tripoli, Libya. A second aim is to examine the association of age, gestation period, residence, family size, and miscarriage history with the CMV seroprevalence.

Methods

Study Design and Population

This cross-sectional study included a total of 202 pregnant Libyan women residing in the city of Tripoli, aged 18-47 years, admitted to different diagnostic laboratories, including the Al-Jalaa Maternity Hospital laboratory, for serum analysis for CMV antibodies. The study period was from September to December 2025. Out of 202 pregnant women who participated in the study, 75 were obtained from the Al-Jalaa Maternity Hospital laboratory, and those specifically subjected to face structured questionnaire interviews, which included questions related to gestational age, place of residence, miscarriage, and family size. The samples with inadequate serum or those that did not consent to be involved in the study were excluded.

Sample Collection Procedure and Laboratory Analysis

After having informed consent from participants, blood samples were collected using white vacuum tubes (white tubes with red caps). After collection, the samples were left at room temperature for 30 minutes to 2 hours to allow clotting. Subsequently, samples were analyzed according to manufacturer recommendations. Briefly, clotted blood samples were centrifuged for 5–10 minutes to separate the serum. The serum was carefully transferred into labeled microtubes and stored at 2–8°C until a sufficient number of samples were collected for analysis. Before analysis, the analyzers were calibrated first at room temperature, and then the serum samples were placed in their designated racks. During automated measurement, the Roche Cobas e 411 analyzer adjusted the samples at 37°C to ensure proper interaction between the reagents and antibodies.

Following analysis, the results were obtained and categorized as negative, inconclusive, or affirmative in accordance with the kit's instructions as follows: For CMV IgG: negative <0.5 IU/mL, inconclusive 0.5 – <1.0 IU/mL, and positive ≥1.0 IU/mL. For CMV IgM: negative <0.7 COI, inconclusive 0.7 – <1.0 COI, and positive ≥1.0 COI. Where COI stands for cut-off index, used as a reference to provide either a positive or negative result.

Statistical Data Analysis

Data was processed using Python 3.11 employing the pandas, numpy, scipy, and matplotlib libraries. Continuous variables were described using mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Seroprevalence of IgG and IgM was calculated as the proportion of positive cases within each category. Owing to the skewed distribution of antibody titres, geometric mean

Received*: 02-11-2025 -* ***Accepted****: 29-12-2025 -* ***Published****: 06-01-2026*

titres (GMTs) and their 95% confidence intervals (95% CI) were derived from log-transformed IgG and IgM values using the subset of 202 cases, with all graphical outputs generated in Python.

Results

A total of 202 blood samples were collected from pregnant women who attended different diagnostic laboratories in Tripoli city. Their ages ranged from 18 to 47 years, with a mean age of 31.2 ± 6.5 years (Table 1). The distribution of their age is shown in (Table 2). The means of CMV-specific IgG and IgM antibodies and their overall prevalence are presented in (Table 1) and (Table 3), respectively.

Table 1. Descriptive Statistics of Continuous Variables

Variable	N	Mean ± SD	(Min–Max)
Age	202	31.2 ± 6.5	18 – 47
IgG (IU/mL)	202	312.0 ± 709.3	0.0 – 8087
IgM (COI)	202	17.4 ± 78.1	0.0 – 500

Table 2. Age Group Distribution

Age group	Count	Percent (%)
18–24	28	13.9%
25–29	57	28.2%
30–34	55	27.2%
35–39	35	17.3%
40–47	27	13.4%

Table 3. Overall IgG and IgM Seroprevalence

Category	Count (n)	Percent (%)
IgG Positive	131	64.85%
IgG Negative	71	35.15%
IgM Positive	55	27.23%
IgM Negative	147	72.77%

As depicted in Figure 2, the seroprevalence of CMV IgG was high at ~65% (131/202), and the seroprevalence of CMV IgM was low at ~27% (55/202).

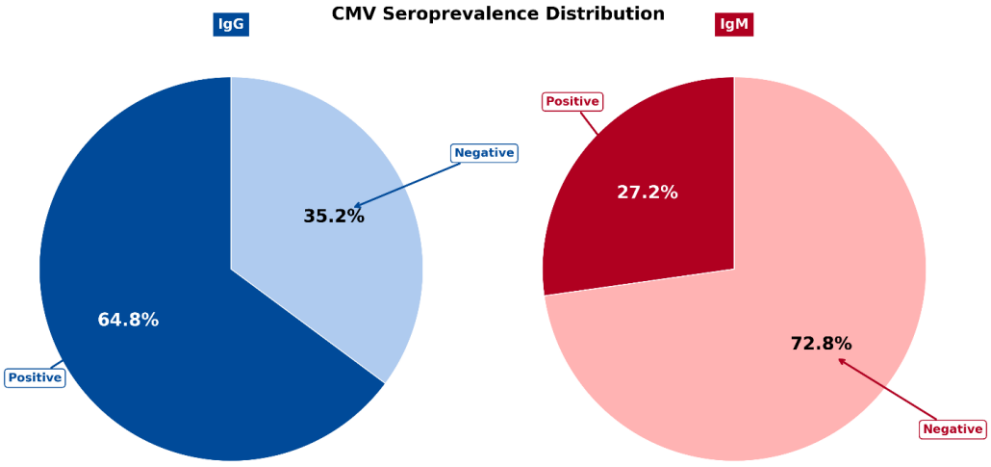

Figure 1. CMV IgG and IgM Seroprevalence Distribution Among the Study Population

In order to compare these percentages more precisely, variability in IgG and IgM positivity across age groups was examined. (Table 4) shows that IgG seropositivity remains consistently high across all age categories. Nevertheless, in the case of IgM seropositivity, the scenario was different. There were differences observed in IgM positivity, indicating potential variation in recent infection risk; for instance, women aged 30–34 show relatively higher IgM positivity, hinting at possible recent exposure clusters within this age range (Table 4).

Received*: 02-11-2025 -* ***Accepted****: 29-12-2025 -* ***Published****: 06-01-2026*

https://doi.org/10.54361/ajmas.269106

***Table 4. IgG and IgM Seropositivity Across Age Groups*Age**

Group (years)	Total (n)	IgG Positive (n, %)	IgG Negative (n, %)	IgM Positive (n, %)	IgM Negative (n, %)
18–24	28	17 (60.7%)	11 (39.3%)	9 (32.1%)	19 (67.9%)
25–29	57	44 (77.2%)	13 (22.8%)	9 (15.8%)	48 (84.2%)
30–34	55	30 (54.5%)	25 (45.5%)	20 (36.4%)	35 (63.6%)
35–39	35	23 (65.7%)	12 (34.3%)	8 (22.9%)	27 (77.1%)
40–47	27	17 (63.0%)	10 (37.0%)	9 (33.3%)	18 (66.7%)

To support our findings and provide a robust measure of average antibody levels and their associated statistical precision, GMTs with 95% CI were applied. The average antibody levels (IgG and IgM) for each age group were analyzed using GMTs, along with a 95% CI. As shown in (Table 5), IgG GMTs values were highest among women aged 25–29 (24.9, 95% CI: 9.7–63.6) and lowest in the 30–34 age group (4.7, 95% CI: 1.9–11.8), while IgM GMT peaked in the 30–34 group (1.9, 95% CI: 1.1–3.5) (Figure 2).

***Table 5. IgG and IgM GMT with 95% CI by Age Group*Age**

Group (years)	IgG GMT (95% CI)	IgM GMT (95% CI)
18–24	10.6 (2.6–43.0)	0.9 (0.4–2.0)
25–29	24.9 (9.7–63.6)	0.3 (0.2–0.6)
30–34	4.7 (1.9–11.8)	1.9 (1.1–3.5)
35–39	13.1 (3.7–46.8)	0.7 (0.4–1.2)
40–47	13.2 (3.5–50.2)	0.7 (0.3–1.5)

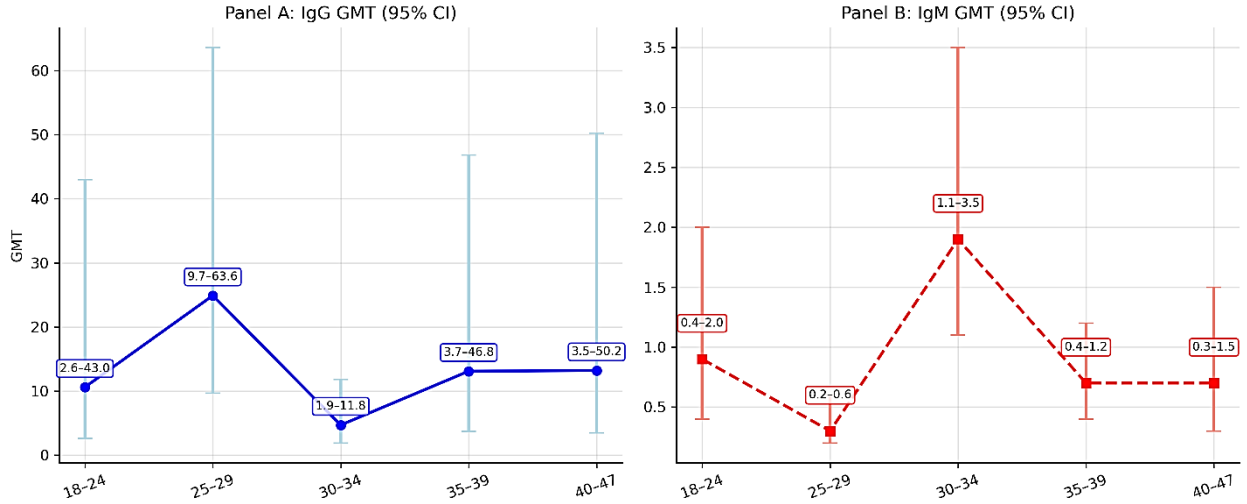

Figure 2. Age-Stratified Geometric Mean Titres (GMTs) of CMV IgG and IgM with 95% Confidence Intervals

Meanwhile, our attention was directed towards the 75 samples collected from the laboratory of Al-Jalaa Maternity Hospital (see material and methods), as the high standardization in the pre-analytical phase within hospitals contributes to data quality and reliability. GMTs presented in (Table 6) demonstrate clear variability in IgG and IgM antibody levels across key epidemiological subgroups, with the overall IgG GMT of 304.86 (95% CI: 213.52 – 435.28) and the low IgM GMT of 0.27 (95% CI: 0.25 – 0.30).

Women in the first and second trimesters show noticeably higher IgG GMTs (370.83, 95% CI: 206.46 – 666.06) and (337.62, 95% CI: 243.72 – 467.70) respectively, compared with those in the third trimester (281.20, 95% CI: 163.40 – 483.94). (Table 6). Likewise, the residence patterns indicate higher IgG GMT among village residents (352.41, 95% CI: 222.75 – 557.56) than city residents (285.93, 95% CI: 178.07 – 459.12). While the history of miscarriage shows only minor variations between the groups, with women who have not experienced miscarriage exhibiting somewhat higher GMTs. Finally, family size shows a progressive rise in IgG GMT from smaller to larger households, peaking at 680 IU/mL in families with more than eight members (Table 6).

Received*: 02-11-2025 -* ***Accepted****: 29-12-2025 -* ***Published****: 06-01-2026*

Table 6. Geometric Mean Titers (GMTs) and 95% CI by Gestational Age, Residence, Miscarriage, and Family Size

Variable	Category	N	GMT (IgG) 95% CI	GMT (IgM) 95% CI
Overall	—	75	304.86 (213.52 – 435.28)	0.27 (0.25 – 0.30)
Gestational Age	1st	10	370.83 (206.46 – 666.06)	0.37 (0.20 – 0.66)
	2nd	18	337.62 (243.72 – 467.70)	0.33 (0.23 – 0.48)
	3rd	47	281.2 (163.40 – 483.94)	0.28 (0.16 – 0.48)
Residence	City	52	285.93 (178.07 – 459.12)	0.27 (0.24 – 0.31)
	Village	23	352.41 (222.75 – 557.56)	0.27 (0.23 – 0.32)
Miscarriage	No	45	323.32 (209.24 – 499.62)	0.32 (0.20 – 0.49)
	Yes	30	279.12 (151.13 – 515.51)	0.27 (0.15 – 0.52)
Family Size	2–3	46	269.21 (157.11 – 461.27)	0.28 (0.25 – 0.32)
	4–6	27	363.11 (251.28 – 524.71)	0.26 (0.22 – 0.31)
	>8	1	680 (—)	0.23 (—)

Discussion

In the present study, 64.85% of our antenatal samples were estimated to be seropositive for CMV IgG, while 27.23% of the samples were IgM positive (Table 3 & Figure 1). Furthermore, GMT values reveal substantial variability across age categories, indicating variability in immune response intensity and timing of exposure (Table 5 & Figure 2). Moreover, we noticed that in the first trimester, village residents and large family size showed high CMV IgG levels (Table 6). The high IgG seroprevalence observed in our study (~65%) indicates substantial past exposure to the virus among participants. Conversely, the lower IgM seropositivity (~27%) may reflect fewer recent or ongoing infections. This trend is commonly observed in populations with extensive historical exposure to the virus, but where current transmission is relatively low [10]. Numerous publications have underlined that high IgG seroprevalence with low IgM is typical in populations where historical CMV circulation is common, indicating the importance of these findings for preventive strategies, including vaccination development [6, 8, 10].

Seroprevalence of CMV by age groups demonstrated high IgG levels across all age groups, ranging from 54.5% in those aged 30-34 to 77.2% in the 25-29 age group, suggesting widespread past exposure unrelated to age. In contrast, IgM positivity was highest at 36.4% in the 30–34-year age group, hinting at possible recent exposure clusters within this age range in particular (Table 4). This result trend aligned with previous studies from Singapore [28], China [29], Sudan [20] and Ethiopia [30] but contrary to our findings, report from Kenya by Maingi *et al.*, who indicated raised IgM level among younger women, although they reported that the seropositivity rate for CMV IgG was 86.8% and for the IgM rate of 2.1% [31]. It is plausible to emphasize that high IgG seroprevalence with low IgM is globally observed, but geographically differs markedly according to socioeconomic status, urbanization, and access to healthcare, with age-related IgM variability observed across diverse populations [29, 32].

The utilization of GMTs calculation in this study delivers further insight into immune response intensity and helps decipher the conundrum of the Seroprevalence of CMV among Libyan women. GMTs' values reveal substantial variability in antibody magnitude across age categories (Table 5 & Figure 2). The wide confidence intervals (95% CI) in several groups suggest within-group variation in immune responses (Table 5). This means that lower GMTs in some age ranges may indicate longer time since exposure or weaker immunological responses, while higher GMTs may reflect more recent or more intense immunological stimulation. Perhaps some observations have contradicted this notion. A study conducted in Italy by Trombetta and colleagues found no notable differences in the GMTs among different age groups [33]. However, the difference in antibody levels across different age groups was aligned with previous findings, suggesting that certain demographics may experience more frequent recent or repeated exposures [29, 34]. Gestational age analysis revealed higher IgG GMTs in the first (370.83, 95% CI: 206.46 – 666.06) and second trimesters (337.62, 95% CI: 243.72 – 467.70) compared to the third trimester (281.20, 95% CI: 163.40 – 483.94), suggesting stronger or more recent immunological stimulation earlier in pregnancy. IgM GMTs remained low across trimesters, indicating limited ongoing infection (Table 6). This trimester-dependent pattern aligns with observations from Uganda and Turkey, which indicated that maternal immune adaptation can influence CMV antibody titers, particularly during early pregnancy [12, 34, 35].

Our investigation also revealed an increase in the CMV IgG seroprevalence in pregnant women residing in villages (352.4, 95% CI: 222.75 – 557.56) compared to those living in the city (285.93, 95% CI: 178.07 – 459.12), suggesting a potentially greater cumulative exposure in rural environments (Table 6). Similar observations were noted in Sudan and Ethiopia, indicating that rural communities, characterized by larger family sizes and greater social interactions, encounter higher rates of CMV transmission. [20, 30]. Supporting this notion, we observe a progressive rise in IgG GMT from smaller to larger households, peaking at 680 IU/mL in families with more than eight members. This could perhaps be explained by the reflection of increased transmission opportunities in crowded living conditions [10]. IgM GMTs remain

Received*: 02-11-2025 -* ***Accepted****: 29-12-2025 -* ***Published****: 06-01-2026*

uniformly low across all categories, further supporting the interpretation that recent viral activity within this population is limited.

The history of miscarriage shows only minor variations between the groups, with women who have not experienced miscarriage exhibiting somewhat higher GMTs, although wide confidence intervals indicate heterogeneous immune responses (Table 6). Notably, IgM GMTs were again low irrespective of miscarriage conditions, aligning with recent studies from Singapore and Turkey that indicated acute infections are not significantly linked to miscarriage in groups with substantial previous exposure [28, 35].

The distribution of serostatus obtained in this study further highlighted their trends among Libyan pregnant women. IgG positivity remained consistently high across all groups. In contrast, IgM positivity exhibited some variation, being more prevalent among women in their first trimester and those who experienced a miscarriage, which suggests the presence of recent exposure clusters. This fluctuation aligns with findings from China and Uganda, highlighting the need to consider obstetric circumstances when interpreting serological data [29,34]. Combining these results with previous observations indicates that both historical exposure and current immune modulation influence CMV seroprevalence during pregnancy [6,12].

Conclusion

In summary, our findings indicate that the majority of pregnant women in Tripoli city had previously been exposed to CMV, whereas only a reduced number displayed recent infections. Factors such as age, gestational stage, place of residence, and family size impacted antibody levels, with higher rates of past exposure observed in early pregnancy, rural locations, or larger families. Our results indicate a significant level of immunization against CMV among pregnant women in Tripoli, resulting in a reduced risk of primary infection during pregnancy. It is important to apply early routine testing for CMV antibodies and identify at-risk women to protect maternal and fetal health. Moreover, increasing awareness of CMV transmission and promoting hygiene practices, especially in larger households, can effectively mitigate infection risks. Further investigations are required to enhance the understanding of maternal CMV infection, potentially by increasing the sample size and broader geographic scope.

Conflict of interest. Nil

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Received: *02-11-2025* - ***Accepted***: *29-12-2025* - ***Published***: *06-01-2026*

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Received: *02-11-2025* - ***Accepted***: *29-12-2025* - ***Published***: *06-01-2026*