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Awareness and knowledge of cytomegalovirus infection among pregnant women in French-speaking Switzerland

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Abstract

Background In Switzerland, cytomegalovirus (CMV) is the most common congenital infection, affecting more than 400 newborns per year. It is also the leading non-genetic cause of neurosensory impairment in children. The aims of this study were to assess the awareness, general knowledge and knowledge of hygiene measures related to CMV among pregnant women in French-speaking Switzerland, as well as identify baseline characteristics potentially associated with a better knowledge of CMV.

Methods A regional cross-sectionnal study carried out in French-speaking Switzerland between May and December 2022, using a 36-item questionnaire available through a QR code.

Results The majority of pregnant women surveyed, 61.6% (514/834), had already heard about CMV. Half the participants (50.4%, 375/743) knew how to protect themselves against this infection. Only 7.2% (60/834) were aware of all the consequences of congenital CMV infection in newborns, and only 1.2% (10/834) knew all the general facts about this virus (transmission, screening, treatment, fetal and maternal risks). An education above secondary level and having a high-risk profession (daycare of healthcare providers) appeared to be factors independently associated with greater awareness and knowledge of CMV, and of the hygiene measures to protect against it. Having been followed by a midwife (only or in addition to an obstetrician) was also associated with a greater knowledge of the virus, and age over 30 and being multiparous were also factors independently associated with a better knowledge of hygiene measures to adopt against CMV.

Conclusion Awareness of CMV among pregnant women appears to have improved since a previous study conducted in Geneva in 2015. While knowledge of preventive measures among participants was insufficient to ensure comprehensive protection against CMV infection, it represents a significant improvement compared

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to previous studies. Further efforts are needed to enhance this knowledge to maximize its potential impact on prevention behaviors.

Keywords Cytomegalovirus, Congenital CMV, Pregnancy, Healthcare, Knowledge, Awareness, Screening, Prevention, Hygiene measures

Introduction

In Switzerland, as in other European countries, cytomegalovirus (CMV) is currently the most common congenital infection, affecting more than 400 newborns per year [1]. It is also the leading cause of non-genetic neurosensory deficits in children [2]. Maternal CMV primary or secondary infections are caused by direct or indirect exposure to infected body fluids (saliva, urine, blood or sexual secretions) [3]. The virus can then be vertically transmitted to the fetus with a risk increasing with gestational age (from 21% in the periconceptional period to 66% in the last trimester) [4]. The risk of vertical transmission seems 4 to 10 times lower in immune women who have a reinfection or reactivation during pregnancy [5, 6]. The main periods at risk for fetuses are the periconceptional period and the first trimester, as congenital CMV infection can lead to irreversible embryopathy with sequelae ranging from neurosensory hearing loss to cerebral palsy (19 to 29% of cases) [4, 7].

Although not included in the Swiss prenatal screening recommendations, the latest guidelines of the Swiss Society of Gynecology and Obstetrics (SGGO) recommend that women should be systematically informed about the risks associated with congenital CMV infections, the hygiene measures to be taken, and the possibility of CMV serological screening in early pregnancy [1]. CMV screening is particularly useful for identifying seroconversion in early pregnancy in at-risk populations (those in contact with young children, women who have already had a child, or those working with children under 5 years of age), thus enabling early prenatal diagnosis and, depending on the situation, secondary or tertiary prevention [8].

By reducing the risk of seroconversion during pregnancy by a factor of 5, primary prevention using hygienic measures to avoid primary CMV infection and reinfection remains the most effective prevention strategy [9]. However, as shown in a recent survey of health professionals in French-speaking Switzerland, their knowledge and practice of prevention differ drastically from one caregiver to another [10]. These discrepancies in practices lead to heterogeneity in women's knowledge, with only 19.7% reporting having received information on preventive measures related to CMV infection in a study carried out in Geneva in 2015[11,12]. These divergent practices pose a threat to the health of women and their unborn babies. Healthcare professionals play a crucial role in safeguarding and promoting women's health throughout pregnancy. However, gaps in their knowledge about CMV are affecting women's understanding of the infection, indicating that it remains an underestimated disease among both healthcare professionals and the general population population [13, 14]. According to a study carried out in two French maternity hospitals, women's knowledge of CMV ranged from 34 to 74%, depending on the hospital they attended [15]. This inequity in access to prevention should prompt the healthcare community to act. Even more so, as a Spanish study showed that 89% of participants expressed the need for more information on CMV [16]. But to meet demand and have an impact on the seroconversion rate, caregivers need to be aware of the risks associated with seroconversion during pregnancy. Their information must be clear and up to date, to give women the practical and theoretical tools to protect their health and that of their baby. The last decade has seen major advances in understanding the importance of CMV infection, its consequences and the pathophysiology of the virus. The question is whether this growing awareness within the scientific community has had an impact on the knowledge of pregnant women in Switzerland. The main objective of this study was therefore to assess the awareness, general knowledge and knowledge of hygiene measures related to CMV among pregnant women in French-speaking Switzerland. The secondary objective was to identify which of their characteristics was potentially associated with a better knowledge of CMV.

Material and method

Study design, data collection and population of interest

This regional questionnaire study employed a cross-sectional design to collect data on variables of interest (knowledge of CMV and preventive measures to be implemented) as well as the socio-professional characteristics of the participants. As Switzerland is a country divided into three distinct regions where German, French and Italian are spoken respectively, it was decided that only patients being followed in French-speaking Swiss institutions would be included in the present study. The survey, conducted by the University of Applied Sciences in Health of Lausanne (HESAV) in partnership with hospitals and private practices in French-speaking Switzerland, took place between May 2022 and December 2022. Eligible participants whose follow-up was carried out in one of the partner centers were asked to complete an anonymous 36-item online questionnaire accessible via

a QR code available through a flyer or informative posters available in partner centers. All consenting, adult, and French-speaking pregnant patients were eligible, regardless of the trimester of pregnancy at the time of recruitment, and their immune status for CMV. The eligible population was estimated at 11,000, based on an annual birth rate of 17,000 in French-speaking Switzerland.

Data sources/measurement

The questionnaire was written in French and was based on different questionnaires collected via a literature review whose themes addressed those of interest for this study [17]. The questionnaire was presented to an expert committee comprising midwives, biologists and physicians, and the final version comprising all 36 questions (Supplementary material) was tested in a pilot phase involving 30 pregnant women, first to assess the questionnaire's internal consistency (Cronbach alpha > 0.7) and then one week later to evaluate its reproducibility over time (Kappa index > 0.8). The questionnaire included questions related to the primary endpoint of assessing pregnant women's awareness of congenital CMV (assessed via a binary variable), but also in connection with the secondary endpoints of assessing pregnant women's knowledge of preventive measures and their knowledge of CMV (assessed via binary variables then generated as a score to make them quantitative variables). Based on a proportion of pregnant women aware of CMV of 0.39 highlighted in the 2015 Geneva study [12], and allowing a delta of 0.1 (10% variation on baseline characteristics between aware and non-aware women) with a power set at 0.8 and a significance level of 0.05, the required number of participants was set at 817. This sample size would enable us to meet both the primary and secondary objectives of the study.

Variables

The final questionnaire included variables on the socio-demographic characteristics and previous history of the participants (age, profession, level of education, gestation, parity, trimester of pregnancy, professional following the pregnancy and place of pregnancy follow-up). Participants were also asked about their awareness of CMV infection, including whether they knew they had ever been infected. The history of CMV infection was determined based on self-reported knowledge, reflecting their perceived or known history of CMV rather than a clinically confirmed diagnosis. This approach allowed the collection of participants' understanding of their CMV status without requiring corroborative serological testing. Information on CMV knowledge was assessed using variables addressing the patient's awareness of CMV and other affections, from whom and when they received the information, whether they knew that the virus could be transmitted to the fetus during pregnancy, whether they thought that CMV infection could be dangerous for the mother or the fetus, whether they knew the neonatal clinical signs of congenital CMV infection, whether they know about screening and treatment. Knowledge of hygiene measures and their applicability were assessed using variables that questioned knowledge of the different routes of transmission, as well as assessing their everyday applicability.

Outcomes

The primary outcome was CMV awareness, measured by a binary variable. If the participants indicated that they had been made aware, two categorical variables were used to evaluate the timing of this awareness and the main sources of information (health professional, family, media, etc.). Two secondary outcomes were then developed to assess general CMV knowledge and preventive hygiene measures to be applied to reduce the risk of infection. The participant's knowledge was assessed through variables that covered different areas such as knowledge of existing screening tests, transmission, treatment, maternal and fetal risk, and neonatal clinical signs. A quantitative knowledge score variable was also generated by awarding 1 point per correct answer, creating a 6-point scale. The knowledge of hygiene measures was assessed using binary variables, and a 5-point score (1 point per correct answer) was also generated for data analysis.

Statistical analysis

Descriptive statistics were used to present the baseline characteristics of study participants. Binary variables were presented via their incidences and percentages, as were categorical variables transformed into binary variables for their analysis (age: < 30 years or > 30 years; trimester of pregnancy at the time of participation: <14 weeks or > 14 weeks; primigravida or multigeste: primiparous or multiparous; level of education: high (baccalaureate, master, doctorate) or low (other type of education); occupation: high (employed or self-employed) or other occupations). For continuous variables, normality of their distribution was estimated using the skewness and kurtosis test. Means and standard deviations for variables with a normal distribution were presented, as were medians and interquartile ranges for variables with a non-normal distribution. Univariate analyses were performed to identify socio-demographic and occupational characteristics potentially associated with the primary outcome "CMV awareness" and the secondary outcomes "CMV knowledge" and "knowledge of hygiene measures". Univariate analyses of binary or categorical variables included chi-square and Fisher's exact tests. Univariate analyses of dependent quantitative variables were performed using

Student's t-tests or Mann-Whitney U-tests, depending on their distribution. Multivariate analyses were performed using logistic or general linear regressions to identify potential factors independently associated with the different outcomes, with a selected p-value threshold of 0.10 in the univariate analysis. Multicollinearity of variables was checked using correlation tests. If two covariates showed a correlation with a coefficient > 0.70, one of the two variables was removed from the multivariate analysis. Results of the univariate and multivariate analysis presented either the crude and adjusted odds ratios (OR), or the crude and adjusted coefficients with their 95% confidence intervals (95%CI). The significance threshold for multivariate analyses was $p < 0.05$. We used Stata 17 software for these analyses.

Missing data

A complete case analysis rather than multiple imputations was used in this study due to the presumed low level of missing data (< 5% per variable).

Results

Respondent sample

A total of 992 patients completed the questionnaire. One hundred and two women were not pregnant and were therefore excluded. Finally, 890 pregnant women were recruited to take part in the study (representing 8% of the eligible population), and 834 (93.7%) of them met the primary outcome of whether they were aware of CMV. The secondary outcomes were met by 834 (100%) and 747 (89.6%) participants respectively (Fig. 1).

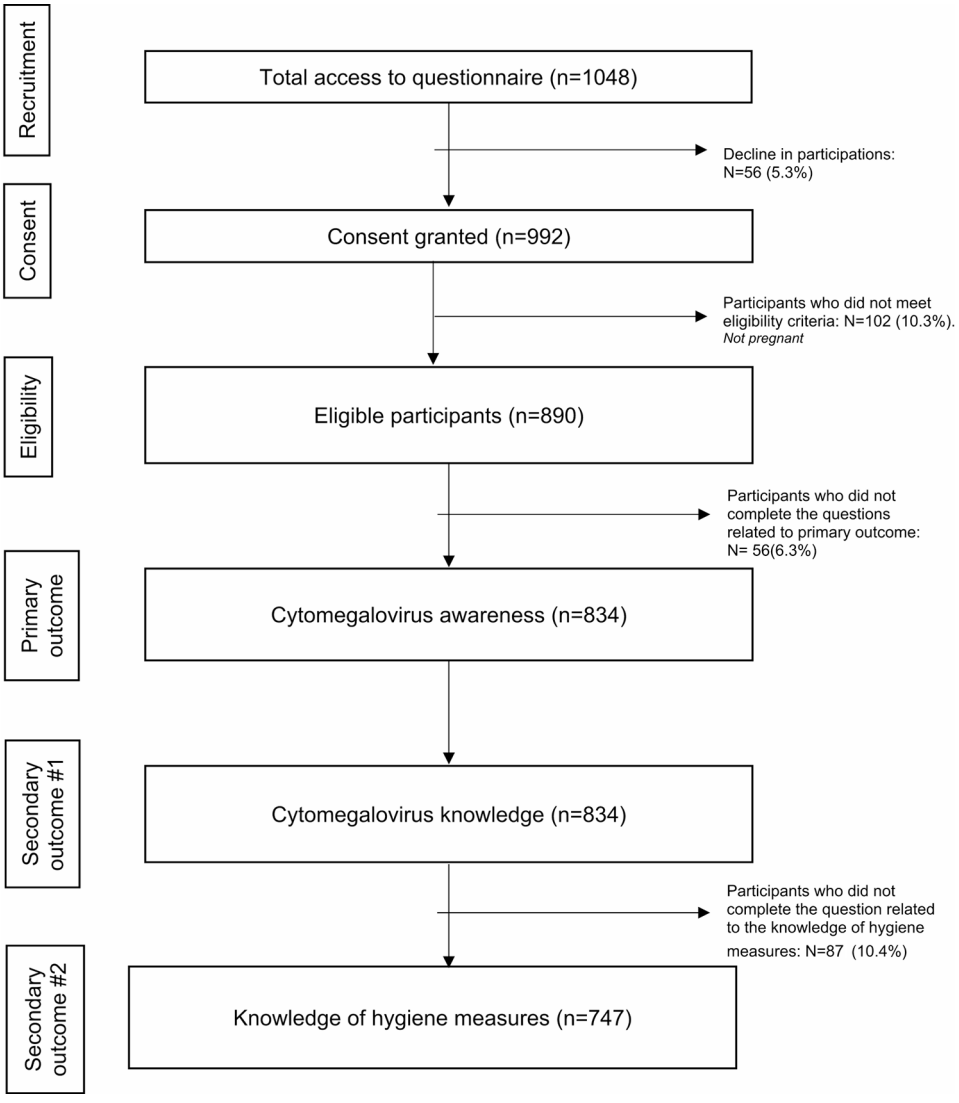

Fig. 1 Flow chart

Table 1 Baseline characteristics of participants

Baseline characteristic	*n* = 834 (%)
Age	
18–20	12 (1.4)
20–29	193 (23.0)
30–39	577 (69.0)
40–49	50 (6.0)
> 50	2 (0.2)
Gestational age	
1st Trimester (< 14 weeks)	202 (24.0)
2nd Trimester (14–27 weeks)	338 (40.5)
3rd Trimester (≥ 28 weeks)	270 (32.0)
Childbirth and post-partum period	24 (2.8)
Education level	
Primary school certificate	10 (1.0)
High school certificate	209 (25.0)
Bachelor	250 (30.0)
Master	289 (34.6)
PhD	53 (6.0)
No diploma/Other	23 (2.7)
At risk profession	
Healthcare	248 (29.0)
Early childhood sector	80 (9.0)
Profession	
Student	16 (1.9)
Employee	681 (81.6)
Housewife	44 (5.3)
Self-employed	39 (4.7)
Manual worker	4 (0.5)
Unemployed	38 (4.6)
Other	12 (1.4)
Parity	
0	423 (51.0)
1	399 (48.0)
2	3 (0.3)
3	1 (0.1)
Gestity	
> 1	450 (54.0)
1	384 (46.0)
Place of pregnancy follow-up (multiple-choice item)	
City practice	431 (51.6)
University hospital	338 (40.5)
Non-teaching hospital	75 (9.0)
Clinic	44 (5.0)
Birth center	29 (3.4)
Professional pregnancy monitoring (multiple-choice item)	
Gynecologist/Obstetrician	771 (92.0)
Midwife	134 (16.0)
General practitioner	17 (2.0)
History of CMV infection	
Yes	138 (16.5)
No	387 (46.0)
I don't know	309 (36.0)

Baseline characteristics

The most represented age group among participants was 30–39 years old (69%; 577/834). The majority of participants completed the questionnaire during their second (40%; 338/834) or third (32%; 270/834) trimester of pregnancy. Around 30% of participants had a Bachelor's degree (250/834) and 25% (209/834) had a secondary school certificate. Of the women surveyed, 29% (248/834) worked in the healthcare sector and 9% (80/834) in the early childhood sector. More than half (53%; 450/834) had already experienced pregnancy before (multigesta) and 48% (399/834) had already given birth to a child (multipara). The majority of women (92%; 771/834) declared that they had been followed by an obstetrician-gynecologist, and half of them (51%; 431/834) in a private practice. As for their serological status, 16% (138/834) had already been infected with CMV (either during or before their pregnancy), and 36% (305/834) did not know their serological status (Table 1).

CMV awareness

Of the 834 women surveyed, 61.6% (514/834) reported being aware of CMV during or before pregnancy. Patients most aware of CMV were in the second trimester of pregnancy (42%; 217/514), compared to those in the first trimester (24%; 127/514) or in the last trimester (30%; 158/514) of pregnancy. CMV was the affection least known by women, compared with other pathologies such as Down syndrome (98%), HIV (98%), toxoplasmosis (94%), rubella (92%), fetal alcohol syndrome (71%), and spina bifida (66%). While 65% of participants reported first hearing about CMV before pregnancy and 29% during the first trimester, awareness levels were highest among women surveyed in the second trimester (42%). The majority of participants said they had received the information from a healthcare professional (60%; 311/514), and their relatives or friends (28%; 144/514) were the second most frequent route of awareness (Fig. 2).

CMV knowledge

When asked about their knowledge of CMV, 78% (652/834) answered that maternal-fetal transmission is possible. A third (35%; 291/834), incorrectly answered that CMV could represent a danger for healthy pregnant woman, and 82% (681/834) correctly answered that the virus could be a danger to the fetus and unborn child. Of the 82% (681/834) who thought the virus was dangerous for the fetus, 50% (340/681) correctly described hearing loss, 55% (380/681) mental retardation, 36% (249/679) microcephaly and 41% (279/679) death as possible consequences of congenital CMV infection. Among the participants surveyed, 17% (119/679) correctly indicated that CMV could induce jaundice, 20% (140/679) convulsions

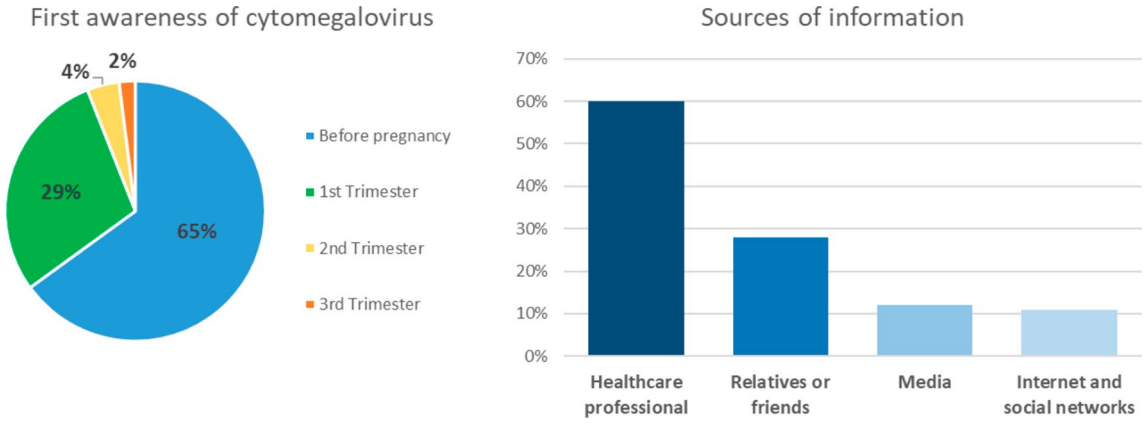

Fig. 2 Time of first awareness of cytomegalovirus and main sources of information

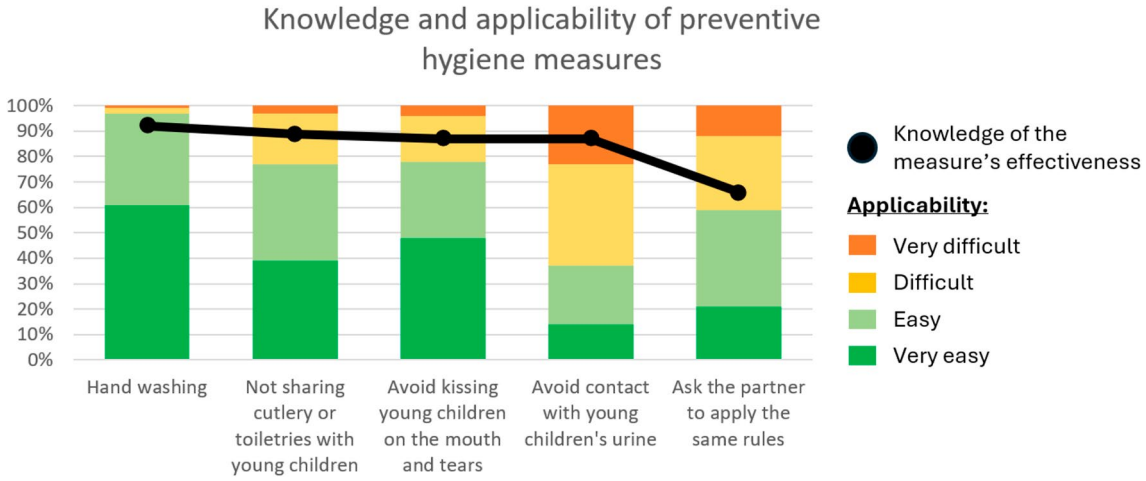

Fig. 3 Knowledge and applicability of preventive hygiene measures

and 31% (214/679) incorrectly answered that CMV could cause limb malformations and 26% (177/679) heart malformations in the infected newborn. A total of 7.2% of participants were aware of all the potential consequences or symptoms of congenital CMV infection in newborns. The majority of participants (77%, 646/834) believed that screening was available, and 32% (266/834) indicated that treatment was available to avoid fetal consequences in case of maternal infection. Only 1.2%(10/834) demonstrated comprehensive knowledge, answering all questions about CMV correctly. The median knowledge score was four out of six (IQR 3–4, Supplementary Fig. 1).

Knowledge of preventive hygiene measures

Most participants (95%, 712/747) answered that hand washing protects against CMV, and 83% (620/747) considered that avoiding a child's eating or toilet utensils protects against CMV infection. Avoiding kissing a child on the mouth is a protective measure for 84% (626/747) of women surveyed. Not being in contact with a child's urine or tears would prevent infection for 86% (643/747) of women. More than half of the participants (62%, 464/747) believed that their partner could also transmit CMV via biological fluids and should apply the same prevention measures as them (Fig. 3).

Half participants (50%, 375/747) answered all 5 questions correctly. The median prevention score was 5 out of 5 (IQR 4–5, Supplementary Fig. 2).

When asked about other preventive measures unrelated to CMV, 37% (279/747) wrongly believed that avoiding cat litter cleaning would protect against infection, and 24% (180/747) that avoiding raw meat and raw milk cheese would protect against CMV.

Applicability of hygiene measures

Most women surveyed (97%; 688/708) indicated that handwashing was a measure that was fairly or very easy to apply (Fig. 2). The same was true for avoiding child feeding utensils, which 78% (348/620) of women felt could be applied on a daily basis. On the other hand, 21% (130/624) of patients surveyed found kissing their child on the mouth difficult to avoid. Moreover, 60% (386/643)

of participants found it difficult or very difficult to avoid contact with their child's urine. More than half (60%; 279/464) of the women thought it would be applicable to ask their partner to follow the same rules of hygiene as themselves to protect themselves against CMV (Fig. 2).

Factors associated with outcomes

The outcomes assessed in this study focused on participants' levels of CMV awareness, general knowledge, and knowledge of preventive hygiene measures. Multivariate analyses identified several factors associated with these outcomes, including multiparity, higher educational levels, and employment in high-risk professions such as healthcare or early childhood sectors. These findings reflect the determinants of awareness and knowledge, which are critical for improving preventive practices and reducing infection risks.

Association between CMV awareness and women characteristics

Multivariate analysis indicated that the variables independently associated with CMV awareness were multiparity (aOR (adjusted odd ratio) = 3.5; 95%CI [1.8–7.1]), educational level above secondary school (aOR = 4.0 [2.4–6.7]), and having high-risk professions in healthcare (aOR = 3.9 [2.1–7.1]) or early childhood (aOR = 2.9 [1.3–6.4]) sectors (Table 2).

Association between CMV knowledge score and women characteristics

In multivariate analyses, the variables that were independently associated with better general knowledge of CMV were being followed by a midwife only or in addition to an obstetrician (aCoeff (adjusted coefficient) = 0.4 [0.1–0.6]), higher education level (aCoeff = 0.9 [0.6–1.1]), working in a healthcare profession (aCoeff f = 0.6; [0.4–0.8]) or in early childhood (aCoeff = 0.8 [0.5–1.1], Table 3).

Association between knowledge of hygiene measures score and women characteristics

In the multivariate analysis, the variables independently associated with better knowledge of CMV preventive measures were age over 30 (aCoeff = 0.7 [0.3-1.0]), parity (aCoeff = 0.5 [0.1–0.8), higher educational level (aCoeff = 0.2 [0.0-0.4]) and occupation in the health (aCoeff = 0.3 [0.0-0.5) or early childhood (aCoeff = 0.5 [0.2–0.9]) sectors (Table 4).

Association between awareness during pregnancy, CMV knowledge score and knowledge of hygiene measures

Among participants who had heard of CMV, the median CMV knowledge score was four out of six (IQR 3–4), whereas the median score was two (IQR 0–3) in participants who had not been made aware of CMV in early pregnancy. The distribution of CMV knowledge scores

Table 2 Univariate and multivariate analyses to identify factors independently influencing CMV awareness

	Patients aware of CMV	Univariate analysis			Multivariate analysis		
Baseline characteristics	N (%)	OR	95% CI	p	aOR	95% CI	p
	514 (62.0)						
Maternal age > 30	422 (82.0)	2.5	1.81–3.45	< 0.001	1.00	0.53–2.10	0.878
Gestity > 1	317 (61.6)	2.26	1.70-3.00	< 0.001	*		
Parity > 0	294 (72.9)	2.81	1.93–3.45	0.001	**3.53**	**1.76–7.13**	**< 0.001**
1st Trimester < 14 weeks	127/202 (62.9)	1.07	0.77–1.48	0.677			
Professional pregnancy monitoring							
Ob/Gyn	479/771 (62.1)	1.31	0.78–2.20	0.304			
Midwife	86/134 (64.2)	1.13	0.77–1.67	0.508			
General practitioner	5/17 (29.4)	0.25	0.08–0.72	0.010	0.84	0.20–3.59	0.818
Place of pregnancy follow-up							
University hospital	208/338 (61.5)	0.99	0.74–1.32	0.964			
Non-university hospital	51/75 (68.0)	1.35	0.81–2.25	0.236			
Clinic	23/44 (52.5)	0.66		0.192			
City practice	280/431 (64.9)	1.33	0.36–1.22	0.041	1.10	0.69–1.74	0.700
Birth center	25/29 (86.2)	4.03	1.01–1.77 1.39-11-71	0.006	*		
Education level > high school	415 (80.7)	3.38	2.48–4.62	<0.001	**3.98**	**2.35–6.74**	**<0.001**
Upper middle class (employees, self-employed)	467/720 (64.9)	2.63	1.75–3.93	<0.001	1.51	0.83–2.77	0.178
At risk profession							
Healthcare	193/248 (77.8)	2.89	2.06–4.07	<0.001	**3.88**	**2.14–7.15**	**< 0.001**
Early childhood sector	63/80 (78.8)	2.48	1.42–4.33	0.008	**2.90**	**1.32–6.37**	**0.009**

Note: n: number, OR: Odds Ratio, aOR: adjusted Odds Ratio, CI: Confidence Interval (95%), p: p-value. The results of the univariate analyses were obtained through chi-square or Fisher's exact tests. The results of the multivariate analyses were obtained through logistic regressions. Only variables with a p-value < 0.10 in the univariate analyses were selected for the multivariate analyses. *Gestity and Birth center were removed from the multivariate analyses because of collinearity with parity and City practice, respectively

Table 3 Univariate and multivariate analyses to identify factors independently influencing CMV knowledge

	Univariate analysis		**Multivariate analysis**	
Baseline characteristics	Coeff (95% CI)	p	aCoeff (95%CI)	p
Maternal age > 30	0.48 (0.24–0.72)	< 0.001	0.21 (-0.04-0.55)	0.094
Gestity > 1	0.15 (-0.07-0.37)	0.179		
Parity > 0	0.20 (-0.27-0.67)	0.410		
1st Trimester < 14 weeks	0.12 (-0.12-0.37)	0.303		
Professional pregnancy monitoring				
Ob/Gyn	0.04 (-0.35-0.44)	0.816		
Midwife	0.39 (0.11–0.67)	0.007	**0.38 (0.12–0.64)**	**0.005**
General practitioner	-1.19 (-1.92- -0.46)	0.001	-0.44 (-1.15-0.26)	0.219
Place of pregnancy follow-up				
University hospital	0.02 (-0.19-0.23)	0.874		
Non-university hospital	0.25 (-0.11-0.61)	0.175		
Clinic	-0.16 (-0.62-0.31)	0.513		
City practice	0.16 (-0.05-0.37)	0.130		
Birth center	0.43 (-0.14-1.00)	0.138		
Education level > high school	1.02 (0.81–1.24)	<0.001	**0.88 (0.64–1.11)**	**< 0.001**
Upper middle class (employees, self-employed)	0.66 (0.36–0.96)	< 0.001	0.22 (-0.07-0.52)	0.135
At risk profession				
Healthcare	0.65 (0.43–0.88)	< 0.001	**0.58 (0.36–0.79)**	**< 0.001**
Early childhood sector	0.56 (0.20–0.91)	0.002	**0.81 (0.48–1.14)**	**< 0.001**

Note: Coeff: coefficient, aCoeff: adjusted Coefficient, CI: Confidence Interval (95%), p: p-value. The results of the univariate analyses were obtained through Mann-Whitney U-tests (the CMV knowledge score does not have a normal distribution, Supplementary Fig. 1). Coefficients were obtained using linear regressions. Only variables with a p-value < 0.10 in the univariate analyses were selected for the multivariate analyses (generalized linear models)

Table 4 Univariate and multivariate analyses to identify factors independently influencing knowledge of hygiene measures

	Univariate analysis		**Multivariate analysis**	
Baseline characteristics	Coeff (95% CI)	p	aCoeff (95%CI)	p
Maternal age > 30	0.62 (0.43–0.81)	< 0.001	**0.67 (0.34-1.00)**	**< 0.001**
Gestity > 1	0.23 (0.07–0.40)	0.006	*	
Parity > 0	0.56 (0.17–0.94)	0.001	**0.47 (0.09–0.84)**	**0.014**
1st Trimester < 14 weeks	0.13 (-0.06-0.33)	0.181		
Professional pregnancy monitoring				
Ob/Gyn	0.14 (-0.17-0.46)	0.372		
Midwife	0.08 (-0.15-0.30)	0.506		
General practitioner	-0.30 (-0.85-0.26)	0.293		
Place of pregnancy follow-up				
University hospital	-0.03 (-0.20-0.14)	0.752		
Non-university hospital	0.24 (-0.05-0.52)	0.111		
Clinic	-0.02 (-0.38-0.35)	0.935		
City practice	-0.14 (-0.30-0.03)	0.108		
Birth center	0.17 (-0.29-0.63)	0.465		
Education level > high school	0.37 (0.18–0.55)	< 0.001	**0.22 (0.02–0.41)**	**0.028**
Upper middle class (employees, self-employed)	0.21 (-0.03-0.46)	0.086	0.13 (-0.18-0.44)	0.410
At risk profession				
Healthcare	0.20 (0.02–0.38)	0.028	**0.27 (0.02–0.51)**	**0.029**
Early childhood sector	0.25 (-0.01-0.52)	0.063	**0.54 (0.21–0.88)**	**< 0.001**

Note: Coeff: coefficient, aCoeff: adjusted Coefficient, CI: Confidence Interval (95%), p: p-value. The results of the univariate analyses were obtained through Mann-Whitney U-tests (the CMV knowledge score does not have a normal distribution, Supplementary Fig. 2). Coefficients were obtained using linear regressions. Only variables with a p-value < 0.10 in the univariate analyses were selected for the multivariate analyses (generalized linear models). *Gestity was removed from the multivariate analyses because of collinearity with parity

differed significantly between them (OR = 2.72 [2.35–3.15], $p < 0.001$).

More than half of women who had heard of CMV (60%, 299/493) scored 5/5 when asked about their knowledge of protective hygiene measures, and their median score was also five (IQR 4–5). Among participants who had not been made aware of CMV in early pregnancy, only 30% (76/250) had a score of 5/5, and their median score was four (IQR 2–5). The distribution of their scores for the knowledge of hygiene measures against CMV differed significantly (OR = 1.93 [1.67–2.23], $p < 0.001$).

Interpretation

CMV awareness

The study found that 61.6% of participants reported being aware of CMV during or before pregnancy, aligning with localized awareness rates observed in France (55.7%) and Italy (60%)[15,18]. Both countries have prevention guidelines similar to those of the SGGO [1], demonstrating the influence of consistent health policies. However, these results represent localized experiences rather than nationally representative data. For instance, a nationwide survey in France, the National Perinatal Survey, revealed that only 16% of pregnant women received information on CMV prevention during pregnancy in

2021 [19], highlighting possible discrepancies between local and national data, as well as the potential role of regional implementation strategies. Similarly, in England, where CMV prevention recommendations are less emphasized, awareness was reported at just 14% [20]. These findings suggest that both the scope of national health policies and the intensity of localized prevention efforts play critical roles in shaping awareness levels. Our study revealed a nearly 20% increase in awareness compared to rates reported in 2015 by Willame et al., likely linked to updates in SGGO recommendations [1]. However, a distinction emerges between awareness and broader knowledge, as highlighted by Mazzitelli et al. (2017). While 61.6% of participants reported being aware of CMV, 82% identified it as a fetal risk. This suggests much of the awareness may originate from indirect sources rather than structured education or counseling. Despite this, partial awareness rarely translated into comprehensive understanding with few participants fully grasping the consequences of CMV infection or its preventive measures. This underscores the need for targeted, comprehensive education to improve actionable knowledge and understanding. Although awareness levels have risen, it remains unclear whether this translates into improved preventive behaviors or reductions in maternal infections or congenital CMV rates. Data from Switzerland (2017–2023) show no clear reduction in congenital CMV, highlighting the need to bridge the gap between awareness and effective prevention. Addressing behavioral barriers and improving the practical applicability of prevention guidelines remain essential to achieving measurable impacts on CMV rates [21].

In comparison, awareness of CMV lags significantly behind that of other conditions, such as toxoplasmosis (94%) [12], 15, 22, 23]. This discrepancy highlights the effectiveness of sustained preventive discourse, as seen in toxoplasmosis awareness campaigns which could serve as a model for improving CMV knowledge [24–26]. Increasing discussions about CMV prevention by healthcare professionals could similarly improve awareness among pregnant women. While not definitively proven to reduce infection rates, educational initiatives and preventive strategies are critical to mitigating risk-taking behaviors during pregnancy [27, 28]. This study found that most participants who were aware of CMV received prevention messages during the pre-conception period or first trimester, key windows when seroconversion poses the highest risk of severe fetal consequences [10, 22, 27, 29]. The higher awareness observed in the second trimester likely reflects cumulative exposure to information over time. While healthcare professionals often provide CMV-related information during the pre-conception period or early pregnancy, as noted by Sartori et al. (2024), participants may require repeated exposure to fully absorb and retain this knowledge. Routine prenatal visits and discussions, which commonly occur in the early second trimester, present additional opportunities for awareness. This distinction between the timing of first hearing about CMV and trimester-specific awareness levels suggests that these measures are complementary rather than contradictory, offering a more nuanced understanding of how awareness develops over time. As other authors have noted [30–32], healthcare professionals are the primary and preferred source of CMV information, as reported by 60% of participants. Strengthening the knowledge and practices of healthcare professionals is critical to improving the quality of CMV prevention messages. However, the lack of robust evidence linking increased awareness to reduced CMV seroconversion rates highlights the need for further research to determine how improved awareness impacts maternal and fetal outcomes.

CMV knowledge

This study evaluated participants' knowledge of six key aspects of CMV: maternal-fetal transmission, potential risks for the mother and baby, neonatal symptoms, screening, and treatment options. The most commonly recognized aspect of CMV among participants was its danger to the fetus, with 82% correctly identifying it as a risk. Knowledge of maternal-fetal transmission was also relatively high, with 78% understanding that the virus could be transmitted during pregnancy. Awareness of screening was widespread (96%), but understanding of treatment options was lower, with only 53% aware that interventions like antivirals could reduce fetal complications. These findings are consistent with earlier studies, such as those by Cordier et al. (2012) and Mazzitelli et al. (2017), which demonstrated that while women are often aware of CMV's risks to the fetus, detailed knowledge of neonatal outcomes and management options remains limited. The median knowledge score of 4/6 reflects moderate understanding but the 1% answered all the general knowledge questions about CMV correctly highlights the complexity of CMV-specific information and the challenges in delivering comprehensive prenatal education. Similar studies have noted that the partial knowledge observed in many populations may stem from the lack of standardized educational initiatives and the overwhelming volume of advice given to pregnant women [15, 18, 33]. Future educational strategies should focus on prioritizing the most impactful knowledge areas to maximize practical benefits. However, it is important to acknowledge that awareness is a crucial first step toward improving knowledge and behavior, and the relatively high level of awareness in this study provides a foundation for further educational interventions. The difficulty patients have in differentiating between various CMV-specific information may be influenced by the

large amount of dietary and hygienic advice they receive in early pregnancy, not only from healthcare providers but also from their social circles. Evidence suggests that such information overload can hinder the retention of key messages [33]. This underscores the importance of tailoring educational strategies to prioritize actionable and relevant information according to individual risk factors. By focusing on the most pertinent guidance for high-risk groups, such as those working in early childhood or healthcare settings [1], education can be made more effective without reducing the breadth of preventive advice provided [33].

Knowledge of hygienic measures

This study found that half of the participants correctly answered five questions on how to protect themselves against CMV infection, a significant improvement compared to a 2015 study in Geneva, where only 19.7% of participants postpartum had been informed about preventive measures during pregnancy [12]. Over 80% of participants in this study identified key preventive practices, such as handwashing, avoiding shared utensils, and limiting exposure to children's saliva and urine. These findings suggest that public health campaigns and prenatal counseling have enhanced awareness of basic hygiene measures. However, awareness of less intuitive transmission routes, such as potential transmission from a partner (62%), remains lower, highlighting a gap for targeted education. Improved knowledge of hygiene measures is crucial, as evidence suggests that following such measures could reduce seroconversion rates by up to 80% [9]. In this study's population run in France, implementing primary prevention strategies for seronegative women could lower the seroconversion rate from 0.42–0.19% [9]. Despite this progress, significant gaps persist. In our study only 33% of participants could distinguish between preventive measures for CMV and those for toxoplasmosis. This aligns with findings by Cordier et al. (2012), who demonstrated that systematic and comprehensive education can substantially increase pregnant women's knowledge of hygiene practices, from 34–60% [13, 15, 34]. One notable finding in this study was the difficulty participants reported in avoiding contact with their child's urine, with 60% indicating that this measure was challenging to implement. In contrast, 97% found handwashing easy to apply. This discrepancy suggests that current recommendations on avoiding contact with urine may lack clarity or practicality. Reformulating this advice to emphasize the importance of thorough handwashing after any contact with urine or other biological fluids could improve adherence to hygiene practices. Providing practical, actionable guidance tailored to the realities of caregiving could significantly enhance the effectiveness of preventive measures. While comprehensive knowledge of all hygiene measures is ideal, partial knowledge of critical practices, such as handwashing and avoiding saliva exposure, may still provide substantial protection [35]. Incremental improvements in awareness could contribute meaningfully to reducing CMV seroconversion rates. Future interventions should focus on the most actionable and impactful preventive measures, particularly for high-risk groups such as healthcare or childcare workers [1]. Tools like flyers, posters, and audiovisual materials in clinical waiting areas can further support these efforts [13, 15, 36]. The results also demonstrate that women are motivated to take an active role in their health and that of their baby, with many participants reporting a willingness to apply recommended preventive practices [37, 38]. This is consistent with the findings of Willame et al. (2015), which highlighted the high acceptability of CMV prevention measures among pregnant women [12]. Therefore, the persistent issue of stable CMV seroconversion rates in recent years is likely due more to limited access to information than to a lack of willingness to implement preventive measures. Several authors advocate for standardized, systematic delivery of CMV information across multiple formats, including written, oral, and audiovisual channels [15, 22]. On a national level, the Federal Office of Public Health supports prevention efforts through tools like electronic health records, which allow patients to access and annotate information for discussion with healthcare professionals during follow-up visits [39]. Such tools could play a critical role in improving knowledge and adherence to preventive strategies in French-speaking Switzerland. Primary prevention through hygiene measures remains Switzerland's preferred approach for reducing CMV infections in pregnant women [9, 40]. However, the role of systematic serological screening for CMV has been a topic of debate for many years [40, 41]. Historically, international guidelines did not recommend universal screening due to insufficient evidence of its benefits [42]. Recent studies, however, have shown that valacyclovir can significantly reduce the risk of vertical transmission and associated fetal complications when used for secondary prevention in first-trimester CMV infections [43–45]. These findings have led some countries to rethink screening recommendations in their prenatal care strategies [46]. In Switzerland, systematic serological screening is not currently recommended. Instead, national guidelines focus on providing pregnant women with information about CMV and offering optional screening early in pregnancy [1]. This non-standardized approach may contribute to inconsistencies in professional practices and reduced emphasis on CMV counseling during pregnancy [47]. The lack of robust supporting evidence, which forms the basis of current guidelines, further complicates adherence to prevention strategies. Building a stronger evidence base

through clinical trials and real-world studies is essential to support more uniform recommendations. Integrating systematic screening into prenatal care could also offer broader benefits, such as improving healthcare professionals' understanding of CMV pathology and enhancing patients' health literacy [48]. Empowering pregnant women with accurate information through screening programs may help them adopt effective preventive behaviors [49].

Target population for improving knowledge factors

The results concerning the factors associated with greater CMV awareness are consistent with those found in the literature. A higher level of education and work in care or early childhood were common factors identified by several authors [12, 15, 23]. Regarding parity, results vary on the impact of these factors. Cordier et al.. (2012) found better knowledge of CMV in multiparous women compared to primiparous women, whereas our study shows no significant difference between these two groups. However, it indicates that multiparous women have a better understanding of preventive measures than primiparous women (58% vs. 43%). Therefore, the preventive message should be adapted and personalized for each patient. A pre-conception consultation should be promoted among women and made more widely accessible, so that they can be made aware of CMV and the hygiene rules to adopt before a possible pregnancy. The postpartum period remain underutilized for primary prevention, despite its importance for primiparous women planning to have a second child [10]. Raising women's awareness before pregnancy is crucial, as noted by various authors [15, 22], but too few healthcare professionals utilize these periods for primary prevention [10]. According to Sartori et al.., only 11% of healthcare professionals engage in primary prevention during the postpartum period [10]. Since non-immune multiparous women are the main group at risk of primary infection in their next pregnancy, the postpartum period should be better utilized by healthcare professionals to raise awareness of CMV for future pregnancies.

Strengths and limitations

This study evaluates a timely topic by being the first in Switzerland to assess pregnant women's knowledge of CMV across different stages of pregnancy and the potential impact of the 2021 Swiss CMV guidelines on good practices in patient management. The sample size was satisfactory ($N = 834$), with a low attrition rate for the primary endpoint, allowing for the primary and secondary outcomes to be addressed with minimal risk of bias. A heterogeneous sample was achieved by distributing the questionnaire across various locations, minimizing sampling bias and enabling the results to be generalized within French-speaking Switzerland. The sample represented all three trimesters evenly: 202 women in the first trimester, 217 in the second, 270 in the third trimester, and 24 in the immediate postpartum period. Accessibility of the questionnaire was facilitated by various means of access provided at recruitment sites, such as flyers and posters with QR codes. However, while these tools improved logistical accessibility, they may not fully address health literacy barriers, as participants with limited health or digital literacy might still face challenges in understanding the study or completing the questionnaire.

However, as participation was voluntary and anonymous, selection bias cannot be ruled out, potentially over-representing patients with higher socio-cultural levels or better knowledge of the topic. The limitation of providing the questionnaire only in French may reduce its generalizability to all patient nationalities. Nationality data were not collected, which could have offered valuable insights into the link between nationalities and outcomes. Furthermore, we cannot estimate the drop-out rate, which could be higher in some communities or among women who were not aware of CMV, and thus overestimate the level of knowledge reported in this study. Participants' access to the Internet during the study introduces a possibility of social desirability bias, as they could look up answers. Furthermore, a Hawthorne effect [50] may have influenced the study, as healthcare professionals informed about the study through meetings and mailings might have increased their efforts to educate patients about CMV.

Implications for practice and future research

This study highlighted significant gaps in women's knowledge of CMV, emphasizing the need to implement measures to improve primary prevention and reduce CMV seroconversion rates during pregnancy. Introducing an additional "Pregnancy and Prevention" consultation or as soon as pregnancy is diagnosed could enhance women's awareness, particularly since only seven prenatal consultations are currently covered by health insurance [51]. Current Swiss healthcare policy should reconsider its approach to prevention. Although raising women's awareness as early as possible is ideal, the lack of reimbursement for preconception consultations limits access to these services before pregnancy. A cost-benefit analysis of such preventive strategies should be undertaken, as studies from other countries have consistently shown that prevention costs are significantly lower than the long-term costs associated with congenital CMV infections [52, 53]. From a public health perspective, placing prevention at the forefront and investing in primary prevention would provide a more efficient and less harmful course of action for the population [31]. Media coverage of CMV and its consequences on pregnancy could also

play a pivotal role in disseminating preventive messages to the wider public in French-speaking Switzerland, achieving broader awareness and engagement.

Given the close relationship between women's knowledge of CMV and that of healthcare professionals [14], improving practitioners' knowledge is a critical area for intervention. Studies, such as that by Sartori et al. (2024), indicate that professional knowledge is more strongly correlated with advanced education, postgraduate training, and conference participation than with the profession itself [10]. Future research should evaluate the effectiveness of ongoing training programs, including mandatory e-learning modules for practitioners working with women during the preconception and early pregnancy periods. Australian evidence demonstrates that continuous training improves professionals' knowledge and confidence in delivering preventive messages [54]. Additionally, investigating the heterogeneity of practices across Switzerland would provide insights into regional variations in women's CMV knowledge and the factors influencing these differences [55]. It would be worthwhile to investigate the possibility of generalizing this study model across the country. Such studies could inform the development of standardized care models to ensure equitable access to CMV prevention services across all regions.

Conclusion

The level of CMV knowledge appears to be higher than that reported during the last decade in Geneva. However, our study is subject to a selection bias that could alter these results, and we still found significant gaps in the patients' knowledge of CMV. Awareness was positively correlated with knowledge of preventive measures, highlighting the need to strengthen the role of healthcare professionals as primary sources of information. Updating their training with the latest scientific recommendations and targeting at-risk patients based on socio-demographic factors can enhance prevention efforts. Until an effective vaccine becomes available, empowering healthcare professionals to educate pregnant women remains essential to reducing CMV-related risks.

Abbreviations

CMV	Cytomegalovirus
SGGO	Swiss Society of Gynecology and Obstetrics
HESAV	Applied Sciences in Health of Lausanne

Supplementary Information

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Supplementary Material 1

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Author contributions

Conceptualization and methodology, D.H., P.S. and L.P.; acquisition of the financial support, P.S. and L.P.; data collection, D.H., B.MDT., A.F., W.R., S.R., R.R., A-C. MB., G.G., B.E., M.P., R.CB., T.V., F.C., J.B., H.L., D.B., and L.P.; writing—original draft preparation, D.H., P.S. and L.P.; writing—review and editing, B.MDT., A.F., W.R., S.R., R.R., A-C. MB., G.G., N. BA. B.E., M.P., R.CB., T.V., F.C., J.B., H.L., and D.B.; All authors have read and agreed to the published version of the manuscript.

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Data availability

The dataset used and analyzed in this study is publicly available on the Synapse directory: https://doi.org/10.7303/syn61841079.1

Declarations

Ethics approval and consent to participate

This study received an approval from the cantonal research ethics commission (CER-VD) on 28 April 2022 (2022 – 00201). This study was carried out in compliance with general ethical principles, in particular by ensuring the collection of anonymized, non-re-identifiable data, with an informed and written consent of the participants. This study conducted on human data adhered to the Helsinki Declaration (https://www.wma.net/policies-post/wma-declaration-of-helsinki/). The study findings are reported according to the STROBE guidelines for cross-sectional studies.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Schäffer LON, Boulvain M, Baud D, Raio L, Duppenthaler A et al. Cytomégalovirus (CMV) et grossesse. 2021. https://www.sggg.ch/fileadmin/user_upload/73_Cytomegalievirus_und_Schwangerschaft_F_aktualisiert.pdf (accessed 02.22.2022.
2. Dollard SC, Grosse SD, Ross DS. New estimates of the prevalence of neurological and sensory sequelae and mortality associated with congenital cytomegalovirus infection. Rev Med Virol. 2007;17(5):355–63.
3. Revello MG, Tibaldi C, Masuelli G, et al. Prevention of primary cytomegalovirus infection in pregnancy. EBioMedicine. 2015;2(9):1205–10.
4. 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. Am J Obstet Gynecol. 2020;223(6):870–83. e11.
5. Picone O, Grangeot-Keros L, Senat M, et al. Cytomegalovirus non-primary infection during pregnancy. Can serology help with diagnosis? J Matern Fetal Neonatal Med. 2017;30(2):224–7.
6. Hadar E, Dorfman E, Bardin R, Gabbay-Benziv R, Amir J, Pardo J. Symptomatic congenital cytomegalovirus disease following non-primary maternal infection: a retrospective cohort study. BMC Infect Dis. 2017;17(1):31.
7. Fowler KB, Boppana SB. Congenital cytomegalovirus infection. Semin Perinatol. 2018;42(3):149–54.
8. Sartori P, Egloff C, Hcini N et al. Primary, secondary, and tertiary prevention of congenital cytomegalovirus infection. Viruses 2023; 15(4).
9. Vauloup-Fellous C, Picone O, Cordier AG, et al. Does hygiene counseling have an impact on the rate of CMV primary infection during pregnancy? Results of a 3-year prospective study in a French hospital. J Clin Virol. 2009;46(Suppl 4):S49–53.
10. Sartori P, Baud D, de Tejada BM, et al. Cytomegalovirus infection during pregnancy: cross-sectional survey of knowledge and prevention practices of healthcare professionals in French-speaking Switzerland. Virol J. 2024;21(1):45.
11. Picone O, Vauloup-Fellous C, Cordier AG, et al. A 2-year study on cytomegalovirus infection during pregnancy in a French hospital. BJOG. 2009;116(6):818–23.
12. Willame A, Blanchard-Rohner G, Combescure C, Irion O, Posfay-Barbe K, Martinez de Tejada B. Awareness of cytomegalovirus infection among pregnant women in Geneva, Switzerland: A Cross-sectional study. Int J Environ Res Public Health. 2015;12(12):15285–97.
13. Calvert A, Vandrevala T, Parsons R, et al. Changing knowledge, attitudes and behaviours towards cytomegalovirus in pregnancy through film-based antenatal education: a feasibility randomised controlled trial of a digital educational intervention. BMC Pregnancy Childbirth. 2021;21(1):565.
14. Beaudoin ML, Renaud C, Boucher M, Kakkar F, Gantt S, Boucoiran I. Perspectives of women on screening and prevention of CMV in pregnancy. Eur J Obstet Gynecol Reprod Biol. 2021;258:409–13.
15. Cordier AG, Guitton S, Vauloup-Fellous C, et al. Awareness of cytomegalovirus infection among pregnant women in France. J Clin Virol. 2012;53(4):332–7.
16. Castillo K, Hawkins-Villarreal A, Valdes-Bango M, et al. Congenital cytomegalovirus awareness and knowledge among health professionals and pregnant women: an action towards prevention. Fetal Diagn Ther. 2022;49(5–6):265–72.
17. Benou S, Dimitriou G, Papaevangelou V, Gkentzi D. Congenital cytomegalovirus infection: do pregnant women and healthcare providers know enough? A systematic review. J Matern Fetal Neonatal Med 2021: 1–10.
18. Mazzitelli M, Micieli M, Votino C et al. Knowledge of Human Cytomegalovirus Infection and Prevention in Pregnant Women: A Baseline, Operational Survey. Infect Dis Obstet Gynecol 2017; 2017: 5495927.
19. Inserm. Enquête Nationale Périnatale Rapport 2021, 2022.
20. Wood S. Raising awareness of cytomegalovirus. Br J Midwifery 2022; 30(5).
21. Confédération Suisse OfdlspO. OFSP-Bulletin 45/23. 2023. https://www.bag.admin.ch/bag/fr/home/das-bag/publikationen/periodika/bag-bulletin.html
22. Jeon J, Victor M, Adler SP et al. Knowledge and awareness of congenital cytomegalovirus among women. Infect Dis Obstet Gynecol 2006; 2006: 80383.
23. Greye H, Henning S, Freese K, et al. Cross-sectional study to assess awareness of cytomegalovirus infection among pregnant women in Germany. BMC Pregnancy Childbirth. 2022;22(1):964.
24. L'Huillier AG, Crisinel PA. [Congenital toxoplasmosis and CMV in Switzerland in 2019]. Rev Med Suisse. 2020;16(682):361–4.
25. Confédération Suisse OfdlspO. La Toxoplasmose Chez les femmes Enceintes et les Enfants En Bas âge: Une Nouvelle stratégie En Suisse. 2008. https://www.admin.ch/gov/fr/accueil/documentation/communiques.msg-id-23990.html
26. Confédération Suisse OfdlspO. Toxoplasmose durant la grossesse: fiche d'information. 2016. https://www.bag.admin.ch/bag/fr/home/krankheiten/krankheiten-im-ueberblick/toxoplasmose.html
27. Cordier AG, Vauloup-Fellous C, Picone O. [Is maternal infection with cytomegalovirus prevention possible?]. Gynecol Obstet Fertil. 2010;38(10):620–3.
28. Perillaud-Dubois C, Bouthry E, Jadoui A, Leng AL, Roque-Afonso AM, Vauloup-Fellous C. Positive predictive values of CMV-IgM and importance of CMV-IgG avidity testing in detecting primary infection in three different clinical settings. A French retrospective cohort study. J Clin Virol. 2020;132:104641.
29. Cannon MJ, Westbrook K, Levis D, Schleiss MR, Thackeray R, Pass RF. Awareness of and behaviors related to child-to-mother transmission of cytomegalovirus. Prev Med. 2012;54(5):351–7.
30. Fellah T, Sibiude J, Vauloup-Fellous C, et al. Evolution of awareness and knowledge of congenital cytomegalovirus infection among health care providers in France between 2011 and 2018. J Clin Virol. 2020;129:104335.
31. Pesch MH, Saunders NA, Abdelnabi S. Cytomegalovirus infection in pregnancy: prevention, presentation, management and neonatal outcomes. J Midwifery Womens Health. 2021;66(3):397–402.
32. Pereboom MT, Mannien J, van Almkerk KD, et al. What information do Dutch midwives give clients about toxoplasmosis, listeriosis and cytomegalovirus prevention? An exploratory study of videotaped consultations. Patient Educ Couns. 2014;96(1):29–35.
33. Hameen-Anttila K, Nordeng H, Kokki E, et al. Multiple information sources and consequences of conflicting information about medicine use during pregnancy: a multinational Internet-based survey. J Med Internet Res. 2014;16(2):e60.
34. Price SM, Bonilla E, Zador P, Levis DM, Kilgo CL, Cannon MJ. Educating women about congenital cytomegalovirus: assessment of health education materials through a web-based survey. BMC Womens Health. 2014;14:144.
35. Indumathi P, Swain D, Jacob TP, Tigga J. Knowledge, perceived threats and protective behaviour related to COVID 19 among pregnant women. Asian J Psychiatr. 2022;72:103091.
36. Lazzaro A, Vo ML, Zeltzer J, et al. Knowledge of congenital cytomegalovirus (CMV) in pregnant women in Australia is low, and improved with education. Aust N Z J Obstet Gynaecol. 2019;59(6):843–9.
37. Vandrevala T, Barber V, Calvert A, et al. Understanding pregnant women's readiness to engage in risk-reducing measures to prevent infections during pregnancy. J Health Psychol. 2021;26(10):1728–40.
38. Lim SL, Tan WC, Tan LK. Awareness of and attitudes toward congenital cytomegalovirus infection among pregnant women in Singapore. Int J Gynaecol Obstet. 2012;117(3):268–72.
39. Confédération Suisse OfdlspO. Prévention dans le domaine des soins. 2022. https://www.bag.admin.ch/bag/fr/home/strategie-und-politik/nationale-gesundheitsstrategien/strategie-nicht-uebertragbare-krankheiten/praevention-in-der-gesundheitsversorgung.html
40. Billette de Villemeur A, Tattevin P, Salmi LR. French Haut conseil de La Sante publique working G. Hygiene promotion might be better than serological screening to deal with cytomegalovirus infection during pregnancy: a methodological appraisal and decision analysis. BMC Infect Dis. 2020;20(1):418.
41. Ville Y. Advocating for cytomegalovirus maternal serologic screening in the first trimester of pregnancy: if you do not know where you are going, you will wind up somewhere else. Am J Obstet Gynecol MFM. 2021;3(4):100356.
42. Deruelle P, de Villemeur AB, Huissoud C. [Systematic screening for cytomegalovirus during pregnancy: A fascinating and passionate subject!]. Gynecol Obstet Fertil Senol. 2024;52(5):303–4.
43. Chatzakis C, Shahar-Nissan K, Faure-Bardon V, et al. The effect of valacyclovir on secondary prevention of congenital cytomegalovirus infection, following primary maternal infection acquired periconceptionally or in the first trimester of pregnancy. An individual patient data meta-analysis. Am J Obstet Gynecol. 2024;230(2):109–17. e2.
44. Faure-Bardon V, Fourgeaud J, Stirnemann J, Leruez-Ville M, Ville Y. Secondary prevention of congenital cytomegalovirus infection with valacyclovir following maternal primary infection in early pregnancy. Ultrasound Obstet Gynecol. 2021;58(4):576–81.
45. Xie M, Tripathi T, Holmes NE, Hui L. Serological screening for cytomegalovirus during pregnancy: A systematic review of clinical practice guidelines and consensus statements. Prenat Diagn. 2023;43(7):959–67.

46. Leruez-Ville M, Ville Y. Is it time for routine prenatal serological screening for congenital cytomegalovirus? Prenat Diagn. 2020;40(13):1671–80.
47. Lugtenberg M, Burgers JS, Westert GP. Effects of evidence-based clinical practice guidelines on quality of care: a systematic review. Qual Saf Health Care. 2009;18(5):385–92.
48. Shaheen NA, Alaskar A, Almuflih A, Muhanna N, Barrak Alzomia S, Hussein MA. Screening practices, knowledge and adherence among health care professionals at a tertiary care hospital. Int J Gen Med. 2021;14:6975–89.
49. Ito H. What should we do to improve patients' adherence?? J Experimental Clin Med. 2013;5(4):127–30.
50. Geoffroy F. Existe-t-il Un effet Hawthorne? Ann Des Mines - Gérer Comprendre. 2019;1(135):42–52.
51. Publique OFdlS. In: Suisse C, editor. Assurance maladie: prestations En Cas de maternité. OFSP; 2024.
52. Fisher SA, Miller ES, Yee LM, Grobman WA, Premkumar A. Universal first-trimester cytomegalovirus screening and valaciclovir prophylaxis in pregnant persons: a cost-effectiveness analysis. Am J Obstet Gynecol MFM. 2022;4(5):100676.
53. Meyers J, Sinha A, Samant S, Candrilli S. The economic burden of congenital cytomegalovirus disease in the first year of life: A retrospective analysis of health insurance claims data in the united States. Clin Ther. 2019;41(6):1040–56. e3.
54. Smithers-Sheedy H, Swinburn K, Waight E et al. eLearning significantly improves maternity professionals' knowledge of the congenital cytomegalovirus prevention guidelines. Aust N Z J Obstet Gynaecol 2022.
55. Aebi-Popp K, Kahlert C, Rauch A, et al. Heterogeneity in testing practices for infections during pregnancy: National survey across Switzerland. Swiss Med Wkly. 2016;146:w14325.

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