

SHORT REPORT

Risk factors for cytomegalovirus seropositivity in a population of day care educators in Montréal, Canada

Serene A. Joseph¹, Claire Beliveau², Cristin J. Muecke³, Elham Rahme⁴, Julio C. Soto⁵, Gordon Flowerdew¹, Lynn Johnston⁶, Donald Langille¹ and Theresa W. Gyorkos^{3,7}

Background	Horizontal transmission of cytomegalovirus (CMV) is common in the day care setting. Day care educators appear to be at a high risk of infection; however, studies are limited.
Aims	To determine the proportion of CMV-seropositive female educators in the day care setting and to identify associated risk factors.
Methods	Educator- and day care-level risk factors for CMV seropositivity were obtained by questionnaires from day care educators and directors, respectively. Sera were collected from educators and analyzed by enzyme-linked immunosorbent assay. Significant independent risk factors for CMV seropositivity were determined using a multivariable logistic regression model which was fitted using the generalized estimating equation method.
Results	CMV seroprevalence in 473 female educators from 81 day care centers in Montréal, Canada, was 57%. Significant risk factors for CMV seropositivity were (i) increasing age (OR _{5-yr} = 1.19; 95% CI = 1.05–1.35), (ii) low-income country of birth (OR = 10.23; 95% CI = 2.64–39.50) or middle-income country of birth (OR = 4.99; 95% CI = 2.39–10.40), (iii) having ≥ 2 children of their own (OR = 1.98; 95% CI = 1.19–3.31) and (iv) child-to-educator ratio >6 (18–35 months old) in a day care center (OR = 1.87; 95% CI = 1.25–2.81).
Conclusions	Day care educators have risks for CMV infection related to their work in the day care setting, as well as personal risk factors. A review of current guidelines for the prevention of CMV infection in day care is needed to ensure that recommendations are evidence based.
Key words	Congenital infection; cytomegalovirus; day care educators; occupational risk.

Background

Cytomegalovirus (CMV) infects $\sim 40\%$ of individuals in developed countries by adulthood, but infection is often asymptomatic [1]. CMV transmission is thought to require intimate contact with infectious secretions or tissues, often urine or saliva [1,2]. The major public health

concern is the risk of congenital infection. CMV can cross the placenta at all stages of pregnancy leading to *in utero* infection [2]. The most severe damage to the fetus occurs to the developing nervous system with possible outcomes which include mental disability and hearing loss [1].

Young children are an important source of CMV infection due to high excretion rates and inadequate hygiene behaviors [3]. This is especially relevant in day care centers [1]. Although child-to-child transmission of CMV may be common in this setting, a more serious implication is CMV acquisition by day care educators, who are mainly females of childbearing age [4]. Daily at-risk activities of day care educators include touching, diapering, washing and feeding of young children [4,5]. Additionally, they may be indirectly exposed to CMV from environmental surfaces [5]. Seroconversion rates of day care educators are higher than in comparison groups [6–9], and occupational risk factors related to CMV infection have been found, such as caring for younger children [6], increased

¹Community Health, Dalhousie University, Halifax, Nova Scotia, Canada.

²Microbiologie, Hôpital Maisonneuve-Rosemont, Montreal, Quebec, Canada.

³Epidemiology and Biostatistics, McGill University, Montreal, Quebec, Canada.

⁴Medicine, McGill University, Montreal, Quebec, Canada.

⁵CCISD, Quebec City, Québec, Canada.

⁶Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

⁷Clinical Epidemiology, Montreal General Hospital, Montreal, Quebec, Canada.

Correspondence to: Theresa Gyorkos. Division of Clinical Epidemiology, Montreal General Hospital, 1650 Cedar Avenue, Montreal, Quebec, Canada.
e-mail: theresa.gyorkos@mcgill.ca

years of day care employment [8] and increased frequency of diaper changing [10]. Although these studies have suggested an occupational risk of day care employment, methodological limitations such as the use of convenience samples decrease the validity of these results.

Improved hygiene behavior and adequate environmental cleaning (surfaces and fomites) have been suggested to prevent CMV transmission [1,3]; however, it is not clear how effective these methods have been.

Therefore, the purpose of this study was to determine the proportion of CMV-seropositive female educators in the day care setting and to identify associated risk factors.

Methods

Details of the study population and data collection have been published previously [11]. Briefly, information on current risk factors was obtained from day care directors and educators. Sera were collected from educators and analyzed using enzyme-linked immunosorbent assay (ELISA) (CMV IgG ELISA, Wampole Laboratories, Cranbury, NJ, USA) according to manufacturer's instructions. An index value ≥ 1.10 was considered positive, ≤ 0.90 was negative and equivocal values were ($n = 8$) excluded.

Variables with $P \leq 0.20$ on univariate logistic regression were included in multivariable logistic regression model building to determine the independent significant risk factors for CMV seropositivity. The generalized estimating equation method was used to account for potential clustering of educator results by day care center (SAS version 8.2, SAS Institute Inc., Cary, NC, USA). Variables were kept in the final model at $P < 0.05$.

Results

A total of 81 day care centers participated in the study. Centers had been in operation for an average of 19 years and 33% were privately owned. Centers were open for a mean number of 56 h/week, and employed an average of 11 educators per center. Centers had an average of six nursery places. The average child-to-educator ratios for children <18 months old, 18–35 months old and ≥ 36 months old were 3.2, 6.1 and 7.5, respectively.

The sociodemographic and epidemiologic characteristics and CMV seropositivity in the 473 educators participating in this study are listed in Table 1. A total of 98% of day care educators were in their childbearing years (<50 years old) and more than two-thirds were born in Canada (69%). A total of 78% of educators were born in a high-income country based on the World Bank classifications [12]. A total of 64% of educators were married or in a common-law relationship, and 55% had at least one child.

An overall seroprevalence of 57% was found. Crude and adjusted estimates of risk factors for CMV seropositivity are presented in Table 2. Variables that were

significant in the final multivariable model (adjusted) are considered to be independent risk factors for CMV seropositivity.

Discussion

This is the first study to find an association between low- or middle-income country of birth and CMV seropositivity. This increased risk may be indicative of CMV infection acquired prior to living in Canada, rather than infection acquired from the day care center. This confirms widely disseminated descriptions of CMV epidemiology in which transmission and infection are higher in developing countries [1].

The association between increasing age and CMV seropositivity is consistent with the epidemiology of CMV in which seropositivity increases steadily throughout adulthood [2]. This association has been found in previous studies in the day care educator population in the USA [8,10].

The fact that children are a major source of CMV is supported by the result of an increased risk of CMV seropositivity for educators with two or more children of their own [1,3]. It appears that exposure to a greater number of children can lead to increased contamination of the home or transmission of the virus to the educator. This relationship may also represent a reduced opportunity to ensure proper hygiene behaviors due to the increased time and responsibility necessary to care for a greater number of children.

In the current study, a child-to-educator ratio >6 in a day care center was associated with an increased risk of CMV seropositivity in the 18- to 35-month-old age range. This is consistent with the fact that children in this age group have the highest CMV excretion rates [3]. These children are more likely to be in diapers than older age children, and they have poor hygiene practices which further increases the potential for CMV transmission to educators. This relationship could be apparent with a greater number of children as a result of decreased time or ability to ensure proper hygiene behaviors.

This study provides current and comprehensive estimates and risk factors for CMV seropositivity in a population of female day care educators in Canada. The results suggest that both individual- and day care-level factors are related to CMV acquisition in this population of day care educators. It is essential to target day care educators for health promotion interventions and improved occupational guidelines for CMV prevention. Evaluation of current recommendations, including serologic screening and preventive leave, is needed to ensure that practices are evidence based.

Strengths of this study include a large sample size, a random sample of centers, heterogeneity of our day care educator population and data analysis which took into account potential clustering. Future research, especially

Table 1. Personal characteristics of 473 day care educators and CMV seropositivity in Montréal, Canada, October 2001

Educator characteristic	Number of educators ^a	Percentage of educators	CMV seropositivity (%)
Age (years)			
<20	4	1	0.0
20–29	148	31.5	45
30–39	167	35.5	57
40–49	107	23	67
≥50	43	9	79
Born in Canada			
No	145	31	85
Yes	328	69	45
Country of birth ^b			
High income	368	78	48
Middle income	75	16	87
Low income	30	6	93
School			
Primary or secondary	46	10	63
Post-secondary	425	90	56
Gross household income (\$)			
<20 000	117	28	62
20 000–39 999	174	41	57
≥40 000	134	31	52
Diploma in ECE or related			
No/in progress	168	36	61
Yes	304	64	55
Marital status			
Single	170	36	51
Married/common law	303	64	60
Number of own children			
0	209	45	46
1	93	20	53
≥2	167	35	73
Currently pregnant			
No/do not know	466	99	56
Yes	6	1	83
Total experience in day care (years)			
<5	163	34.5	55
5–9	130	27.5	56
10–14	103	22	57
≥15	76	16	63
Age group of children cared for			
<18 months old	82	17	63
18–35 months old	136	29	51
≥36 months old	200	42	62
No particular age group	54	11	46
Number of hours worked per week in current day care (h)			
<20	10	2	60
20–29	35	7	60
30–39	283	60	52
≥40	145	31	66
Diapering and food preparation			
Neither	57	13	74
Both	144	32	48
Diaper changing only	163	37	60
Food preparation only	82	18	54

ECE = early childhood education.

^aTotals may not sum to 473 due to missing responses on the questionnaire.^bCountries classified by income according to the World Bank 2001 [11].

Table 2. Risk factors for CMV seropositivity in 473 female day care educators in Montréal, Canada, October 2001

Variable	Crude OR	95% CI	Adjusted OR ^a	95% CI
Educator-level variable				
Age (per 5-year increment)	1.32	1.19–1.46	1.19	1.05–1.35
Country of birth ^b (reference high income)				
Low income	15.27	3.59–65.03	10.23	2.64–39.50
Middle income	7.09	3.53–14.23	4.99	2.39–10.40
Diploma in ECE or related	0.78	0.53–1.14		
Married/common law	1.49	1.02–2.18		
Having ≥2 own children (reference <2)	2.90	1.92–4.36	1.98	1.19–3.31
Total experience in day care (per 5-year increment)	1.10	0.95–1.28		
Age group of children cared for (reference 18–35 months old)				
<18 months old	1.68	0.96–2.95		
≥36 months old	1.55	1.00–2.41		
No particular age group	0.84	0.45–1.57		
Diapering and food preparation (reference neither)				
Both	0.33	0.17–0.65		
Diaper changing only	0.54	0.28–1.05		
Food preparation only	0.41	0.20–0.86		
Day care-level variable				
Private status	1.87	1.22–2.85		
Day care accepts part-time children	0.70	0.48–1.02		
Day care has a routine for washing surfaces	1.66	0.76–3.64		
Child-to-educator ratio >6 (18–35 months old) (reference ≤6)	2.06	1.40–3.02	1.87	1.25–2.81
Number of hours open per week (per hour)	1.03	1.00–1.06		
Number of sinks in use by children (per sink)	0.97	0.94–1.01		

ECE = early childhood education.

^aVariables having a statistically significant *P* value (*P* < 0.05) in the final multivariable model are indicated.

^bCountries classified by income according to the World Bank 2001 [11].

of a longitudinal nature and including comparisons with other occupational groups, would help to further clarify the importance of the risk of CMV infection in this occupational group.

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Conflicts of interest

None declared.

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