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Seroprevalence of parvovirus B19 infection in daycare educators

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SUMMARY

This study was undertaken to provide first-time estimates for the seroprevalence of parvovirus B19 infection among daycare educators in Montréal, Canada, and to identify factors associated with seropositivity. A cross-sectional design was used. Directors and educators from 81 daycare centres (DCCs) were surveyed about DCC and personal characteristics respectively, and serum samples from 477 female educators were tested for parvovirus B19 IgG antibodies. The seroprevalence of parvovirus B19 was 70%. Parvovirus B19 seropositivity was significantly associated with age and with working experience in DCCs, but the latter association was restricted to educators aged less than 40 years. In conclusion, working as a daycare educator appears to be associated with increased risk of acquiring parvovirus B19 infection, but this finding will require further investigation. Because of the large proportion of educators susceptible to acquiring parvovirus B19 infection, our findings also highlight the need for preventive measures.

INTRODUCTION

Parvovirus B19 is the only member of the Parvoviridae family known to be pathogenic to humans. It is the causal agent of erythema infectiosum, also known as fifth disease [1]. Maternal infection during pregnancy is associated with an increased risk of hydrops fetalis and fetal loss [2]. Experimental inoculation of human volunteers has shown that the major route of shedding of parvovirus B19 is respiratory secretions (saliva and nasal fluids), and that shedding occurs before the onset of symptoms [3]. IgG antibodies to parvovirus B19 can be detected in serum 2–3 weeks after acquisition of infection and last for life, providing immunity against re-infection [4]. The risk factor most consistently associated with acquiring parvovirus B19 infection in non-immune subjects is contact with young children, either own children at home or through contact with young children in schools or daycare centres (DCCs) [5–9].

Daycare educators constitute an occupational group at high risk for acquiring parvovirus B19 infection because their work involves close contact with young children. Moreover, being mostly women of reproductive age, they may be susceptible to the most severe effects of parvovirus B19 infection, namely, fetal loss during pregnancy. No data are available on parvovirus B19 seroprevalence in daycare populations, nor in the general Canadian population.

This study was undertaken to determine the seroprevalence of parvovirus B19 infection among

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daycare educators in Montréal, Canada, and to identify factors associated with seropositivity.

METHODS

The research protocol was approved by the Research Ethics Committee of the Research Institute of the McGill University Health Centre (Montréal General Hospital site).

DCCs were selected randomly from among the 472 licensed centres operating in Montréal. The sampling frame was provided by the government ministry: Ministère de la Famille et de l'Enfance. Centres that were not in current operation, did not enrol children under 36 months, or did not employ at least six educators were excluded. Directors were first contacted to obtain verbal consent and to verify the eligibility of their centres, then consent forms and questionnaires were mailed to them. Subsequently, consent forms and questionnaires for completion by educators were mailed to participating centres.

Questionnaires and serum samples from all educators were collected on site at participating DCCs. Sera were transported to the laboratory in ice-packed coolers, and then stored at $-20\ ^{\circ}C$ until testing. IgG antibodies to parvovirus B19 were assayed using ELISA according to the manufacturer's instructions (Biotrin International Ltd, Dublin, Ireland).

The association between parvovirus B19 seropositivity and DCC and individual characteristics was determined by univariate and multivariate logistic regressions. Odds ratios (OR) and 95% confidence intervals (CI) were computed. Variables showing a significant association ($P<0{\cdot}05$) with parvovirus B19 seroprevalence in univariate analyses were included in multivariate logistic regressions. As working experience in daycare, holding a diploma in child care or a related subject, and income were strongly correlated, only the variable experience in daycare was included in the final model. Interactions between independent variables were tested, and significant interaction terms were retained in the final model.

RESULTS

A total of 81 DCC directors and 492 educators participated in the survey. Valid serology results were obtained from 487 educators. Because of the small number of males among participating educators ($n=10$), only results from the 477 female educators are presented here.

The overall seroprevalence of parvovirus B19 was 69·8%. The rate was identical (69·4%) in the subgroup of women of childbearing age (<50 years). In other words, 30·6% of female educators of childbearing age were susceptible to acquiring parvovirus B19 infection. The proportion of susceptibles increased to 52·4% in those aged <25 years.

Characteristics of participating DCCs are presented in Table 1. None of these daycare-level characteristics showed a significant association with the prevalence of parvovirus B19 antibodies.

The majority of participants were between 25 and 44 years of age, with a median of 34 years (range 17–70 years). Ninety-one per cent of the educators interviewed were women aged <50 years of age. Eighty-six per cent of participants worked more than 30 h per week, and 64% held a diploma in child care or a related subject (Table 2). Several of the participants' personal characteristics were correlated, especially age and experience ($r=0{\cdot}498$, $P<0{\cdot}0001$), and age and number of own children ($r=0{\cdot}462$, $P<0{\cdot}0001$). In addition, experience in daycare was significantly associated with income ($F=45{\cdot}62$, 2 D.F., $P<0{\cdot}0001$) and with holding a diploma in child care or a related subject ($F=53{\cdot}22$, 1 D.F., $P<0{\cdot}0001$).

Age, number of own children, income, experience in daycare, age of children cared for, and holding a diploma in child care or a related subject showed significant associations with parvovirus B19 seropositivity in univariate analyses (Table 3).

Variables significantly associated with parvovirus B19 seropositivity were included in a multivariate logistic regression. Holding a diploma in child care or a related subject and income were removed because of their strong association with experience. The educator's number of own children was no longer a significant predictor of parvovirus B19 seropositivity ($P=0{\cdot}5876$), and was, therefore, removed. A significant interaction was found between age and experience ($P<0{\cdot}005$), and this interaction (product) term was, therefore, retained in the final model shown in Table 4. A 5-year increase in daycare working experience was associated with a significantly increased risk of being seropositive for parvovirus at age 20 years (OR 1·76, 95% CI 1·19–2·59) and at age 30 years (OR 1·42, 95% CI 1·05–1·93), but this association disappeared at older ages. The risk of being seropositive varied with the age of children cared for, and was significantly higher in educators in charge of children aged <18 months or ⩾36 months, compared to those in charge of children aged 18–35 months.

Table 1. *Characteristics of participating daycare centres, Montréal, October–December, 2001*

	Number of centres* ($n=81$)	Number of educators ($n=477$)	Parvovirus B19 seroprevalence (%)
Status			
Non-profit (CPE)	55	345	70·43
For-profit	21	116	68·97
Other	5	16	62·50
Open on weekends			
No	76	450	69·11
Yes	5	27	81·48
Percentage of children on social assistance			
None (0%)	38	239	67·36
0·1–5·0%	19	90	70·00
>5·0%	17	105	75·24
Minimum age of children in the daycare (months)			
0–3 months	24	155	70·32
4–12 months	22	141	70·21
>12 months	35	181	69·06
Accept children still in diapers			
No	4	14	50·00
Yes	77	463	70·41
Accept children part-time			
No	31	184	64·67
Yes	49	289	72·66
Staff practice a particular hand-washing technique			
No	13	89	67·42
Yes	59	334	70·06
Unknown	9	54	72·22
Toy-washing routine			
No routine/as needed	7	45	66·67
One or twice daily	7	43	65·12
Once or twice weekly	43	256	68·75
Once or twice monthly	10	68	77·94
Have one, but did not specify	14	65	70·77
Surface-washing routine			
No routine/as needed	9	60	71·67
Once or twice daily	20	119	69·75
Once or twice weekly	29	173	66·47
Once or twice monthly	7	52	78·85
Have one, but did not specify	14	65	69·23

* The number of centres may not add up to 81 due to missing responses in the questionnaires.

DISCUSSION

The finding that 30% of women of reproductive age working in DCCs, and more than 50% of those below 25 years of age were susceptible to acquiring parvovirus B19 infection has important public health implications. It reinforces the importance of prevention of parvovirus B19 infection in pregnant women and especially that of the recent recommendation of the Society of Obstetricians and Gynaecologists of

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Table 2. *Personal characteristics and parvovirus B19 seroprevalence in 477 daycare educators in Montréal, October–December 2001*

	Number of educators*	Parvovirus B19 seroprevalence (%)
Age (years)		
<25	63	47·6
25–34	180	70·6
35–44	149	75·2
⩾45	80	76·3
Born in Canada		
No	144	69·4
Yes	333	70·0
Schooling		
Primary or Secondary	46	63·0
College	285	70·2
University	144	71·5
Income		
$0–$19 999	118	55·1
$20 000–$39 999	175	73·1
$40 000 and over	136	75·7
Marital status		
Single	171	65·5
Spouse or common law	336	72·2
Smoking		
No	377	70·3
Yes	99	67·7
Number of own children		
0 (no children)	212	64·2
1	92	72·8
2	119	73·1
⩾3	50	78·0
Diploma in child care or a related subject		
None or in progress	167	61·1
Completed	309	74·4
Experience in daycare (years)		
<5	162	61·1
5–9	132	71·2
10–14	106	75·5
⩾15	76	77·6
Age of children cared for (months)		
<18	83	79·5
18–35	138	62·3
⩾36	201	73·1
No particular age group	54	61·1
Frequency of diaper changing		
Never	130	69·2
1–10 times/week	130	70·0
⩾11 times/week	216	69·9
Wear gloves when changing diapers		
Yes	284	69·7
Depends	35	60·0
No	39	76·9

* Numbers may not add up to 477 due to missing responses.

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Table 3. *Association between parvovirus B19 seropositivity and personal characteristics of daycare educators: univariate analyses*

	Crude OR	95% CI
Age (5-year increase)	1·21	1·08–1·35
Born in Canada (yes *vs.* no)	1·03	0·67–1·57
Marital status (married or common law *vs.* single)	1·37	0·92–2·05
Number of own children (each additional child)	1·25	1·03–1·50
Income		
$0–$19 999	1·00	Reference*
$20 000–$39 999	1·71	1·08–2·70
$40 000 and over	1·96	1·19–3·23
Experience in daycare (5-year increase)	1·28	1·08–1·52
Hours worked per week (10-h increase)	1·02	0·73–1·42
Age of children cared for (months)		
<18	2·35	1·24–4·43
18–35	1·00	Reference*
⩾36	1·65	1·03–2·62
No particular age group	0·95	0·50–1·81
Diploma in child care or a related subject (completed *vs.* none or in progress)	1·86	1·24–2·78
Wear gloves when changing diapers (no *vs.* yes)	1·45	0·66–3·18

OR, Odds ratio; CI, confidence interval.
* Reference refers to the comparison group.

Table 4. *Association between parvovirus B19 seropositivity and personal characteristics of daycare educators: multivariate analyses*

	OR	95% CI
Age (per 5-year increase)	1·32	1·12–1·56
Experience in daycare (per 5-year increase)		
At age 20	1·76	1·19–2·59
At age 30	1·42	1·05–1·93
At age 40	1·15	0·88–1·52
At age 50	0·94	0·69–1·27
Age of children cared for (months)		
<18 months	2·25	1·17–4·31
18–35 months	1·00	Reference*
⩾36 months	1·65	1·02–2·66
No particular age group	1·06	0·53–2·09

Odds ratios (OR) are adjusted for other variables shown in the table and for the interaction between age and experience. CI, Confidence interval.
* Reference refers to the comparison group.

Canada (SOGC) to assess a pregnant woman's immunity to parvovirus B19 [10].

The association of parvovirus B19 seropositivity with age is consistent with population-based studies in the United Kingdom and Australia [11, 12]. This trend can be explained by the fact that parvovirus B19 antibodies last for life [10]. Because, for parvovirus B19, seropositivity is a synonym of immunity, the increase of seroprevalence with age means that the proportion of individuals susceptible to seroconvert decreases with age, therefore the influence of other exposures on seroprevalence rates at the population level can be expected to decrease with age.

Among younger educators, work experience in daycare was significantly associated with a higher seroprevalence of parvovirus B19. This observation is in agreement with results from other studies [5, 6, 8] which found that working in DCCs may be a risk factor for acquiring parvovirus B19 infection. The negative interaction found between age and daycare experience in this study appears to reflect the effect modification resulting from a smaller proportion of susceptible individuals at older ages.

The variation in seroprevalence depending on the age of children cared for is more puzzling, and our findings do not allow us to propose a definitive explanation. The increased risk in educators working with children aged <18 months may be due to the fact that caring for younger children involves more potential exposure to saliva and respiratory

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secretions, for instance through face and hand washing or for cleaning runny noses. The increased risk in educators working with children aged $\geqslant 36$ months may reflect the fact that acute parvovirus B19 infection occurs mostly in children aged 4–11 years [13].

Parvovirus B19 infection in pregnancy is recognized in Canada as a hazard for the unborn child. According to the current practice guidelines of SOGC, the immune status of pregnant women, either exposed to parvovirus B19 infection or those who have developed symptoms of parvovirus B19 infection, should be ascertained [10]. SOGC recognizes that women who work in DCCs are at increased risk of acquiring this infection [10]. In Québec, the law states that a pregnant woman whose workplace conditions may constitute a risk for the health of her fetus has either the right to be reassigned to a position where there is no such risk, or to obtain a leave from her employment if her employer cannot provide her such reassignment [14]. A survey of Montréal physicians responsible for evaluating withdrawal–reassignment requests showed that a majority of these physicians would grant reassignment to pregnant women of unknown parvovirus B19 serological status if their job involved contact with young children [13].

This study is, to our knowledge, the first that has investigated the seroprevalence of parvovirus B19 in Canada, as well as the first study of risk factors associated with parvovirus B19 seropositivity among daycare educators. Our findings documenting the large proportion of susceptible women in a high-risk occupational group confirm the relevance of preventive measures.

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