Low Seroprevalence of Parvovirus B19 in Taiwanese Children and Young Adults

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Background: This study aimed to evaluate the prevalence of parvovirus B19 antibodies in children and young adults aged ≤30 years old in Taiwan.

Methods: Stored serum samples from healthy volunteers aged 1−29 years in Taipei were randomly selected and tested for antiparvovirus B19 immunoglobulin G by enzyme immunoassay.

Results: A total of 277 serum samples were tested. The overall seroprevalence of parvovirus B19 in Taiwanese children and young adults was 23.1% (64/277) in 2004. The positive rate increased slightly with age; it ranged from 15.0% in those aged 1−4 years to 30.8% in those aged 25−29 years (trend test, \( p = 0.01 \)). The age-adjusted anti-B19 immunoglobulin G seropositive rate was slightly higher in males (27.8%) than in females (18.8%; adjusted odds ratio: 0.56; 95% confidence interval: 0.32−0.99).

Conclusion: Most children and young adults in Taipei City are not immune to parvovirus B19, suggesting that no parvovirus B19 epidemic has occurred in the last few decades.

1. Introduction

Parvovirus B19 is a small DNA virus with a single-stranded, linear genome transmitted among humans via respiratory droplets. B19 infections are most commonly recognized as an erythema infectiosum in children.\(^1,2\) Other modes of transmission include percutaneous exposure to blood products and vertical transmission from the mother to fetus.\(^2\) The incubation period is usually 4−14 days but can be as long as 21 days.\(^2\)

The clinical manifestations associated with B19 infection vary greatly. A mild clinical manifestation, called erythema infectiosum, is most common in infected children.\(^2\) However, severe diseases can occur in high-risk groups. These diseases include aplastic anemia or prolonged bone marrow suppression in patients with hematological disorders or immunocompromised patients. Parvovirus B19 infection is also responsible for 6−9% of fetal losses in pregnant women during the first 20 weeks of gestation.\(^1,3,4\)

In temperate zones, parvovirus B19 infection is common, with a peak incidence in 5−15-year-old children.\(^5−7\) However, it seems that there were no outbreaks of rash illness in children in tropical countries such as Singapore and Taiwan in the late 1990s.\(^8,9\) Lin et al\(^9\) determining the extent of B19 virus infections in Taiwan and found that the overall prevalence of anti-B19 immunoglobulin G (IgG) was 32.8% in the early 1980s. The introduction of
widespread measles, mumps, and rubella vaccination in Taiwan in 1992 means that the infectious rash illnesses in children are likely to be diseases other than measles and rubella. This study aimed to reevaluate the seroepidemiological surveys in children and young adults and to identify the possible susceptible groups if parvovirus B19-related epidemics do occur.

2. Materials and Methods

2.1. Samples

A total of 277 serum samples were randomly selected by age category from the 18,779 original samples used to study the epidemiology of hepatitis B virus by Ni et al in 2004. The use of the stored serum sample for this study was reviewed and approved by the Ethics Committee of the National Taiwan University Hospital. Each stored specimen had a unique identifier plus sex and age. Approximately 50 samples were randomly selected for each age group (Table 1). All study participants were healthy volunteers aged 1–29 years. Participants were recruited from health care clinics, schools, institutes or workplaces; all participants residing in Taipei. The study was approved by the Clinical Research Ethics Committee of the Centers for Disease Control, Taiwan.

2.2. Parvovirus B19 detection assay

B19 IgG was detected by a sandwich enzyme immunoassay according to the manufacturer’s instructions (Biotrin International, Dublin, Ireland). Briefly, 100 μL of each standard and 1:100-diluted samples were added to the parvovirus B19 recombinant VP2 protein-coated microtiter plate wells. After incubation at room temperature for 1 hour, the wells were washed; 100 μL of peroxidase-labeled rabbit anti-human IgG was added and incubated for 30 minutes at 35–39°C. After washing, 100 μL of substrate solution (tetramethylbenzidine) was added and the color was developed for 30 minutes at 35–39°C. After adding 100 μL of stop reagent (0.5 M sulfuric acid), the optical density was read immediately at a filter wavelength of 450 nm with a microplate spectrophotometer. The cut-off values for a positive test were calculated as described by the manufacturer.

2.3. Statistical analysis

Odds ratios (OR) and 95% confidence intervals (CI) were calculated by unconditional logistic regression. The p value for the trend test was measured as the level of significance of the regression coefficient for each ordinary variable in the logistic regression model. Epi Info version 3.4.3 (Centers for Disease Control and Prevention, Atlanta, GA, USA) was used for all statistical analyses, and p < 0.05 was considered statistically significant.

3. Results

Sixty-four of the 277 (23.1%) serum samples tested positive for the B19 IgG antibody. The overall seropositive rate of IgG for males and females was 27.8% (37/133) and 18.8% (27/144), respectively. After adjusting for age, the seropositive rate in females was slightly lower than that in males (adjusted OR: 0.54; 95% CI: 0.30–0.97). As shown in Table 1, the seroprevalence of parvovirus B19 increased slowly with age.
age and ranged from 15.0% in participants aged 1–4 years to 30.8% in those aged 25–29 years (trend test, \( p = 0.02 \); sex-adjusted trend test, \( p = 0.01 \)). An unexpectedly high positive rate (36.0%) was noted in participants aged 10–14 years.

After regrouping the results according to the method used by Lin et al.,\(^9,11\) the seropositive rates for parvovirus B19-IgG were 20.0% (28/140), 22.2% (10/45), and 28.3% (26/92) in the participants aged 1–14 years, 15–19 years, and 20–29 years, respectively (Table 2).\(^9,11\) Using this grouping method, our results showed the same pattern as that reported in 1986.\(^11\) The seroprevalence of parvovirus B19 increases with age. However, the trend test showed a significant result only in tests done in 1986. As shown in Figure 1, the seropositive rate in 2004 was significantly higher (20.0%) in participants aged 1–14 years in comparison to the corresponding rate (10.3%) in 1986 (OR: 2.16; 95% CI: 1.05–4.48). In contrast, there were no differences in the seropositive rates among participants aged 15–19 years or 20–29 years between 1986 and 2004.

4. Discussion

Parvovirus B19 infections are ubiquitous worldwide. Normally, the prevalence of parvovirus B19 antibodies increases with age and varies with population densities, compliance with hand hygiene, and environmental cleanliness,\(^12\) which are all closely related to the presence or absence of outbreaks.\(^13,14\) In earlier reports from Australia, the parvovirus seropositive rates were about 10% in preschool children, 20–30% in school-age children, 50–60% in adults, and higher in older age groups.\(^15\) However, seropositive rates as high as 56–80% have been reported in teenagers in England and Brazil.\(^5,16\) Decreased or delayed levels of seropositivity for parvovirus B19 infections in populations could be associated with a lack of major outbreaks of parvovirus infections.\(^8,17\)

In the current study, the parvovirus B19 seropositive rate in children and young adults was low, suggesting that parvovirus B19 infections have become less common in Taiwan in the past few decades, similar to recent reports from other countries.\(^15\) Like other viral diseases transmitted by airway droplets, children and young adults are the most vulnerable groups. This is partly because participants in this age group are naïve to the virus and have not yet established specific immunity. The proportion of participants showing immunity increases gradually with age. The annual seroconversion rate in elementary schools was reported to be around 5% in the 1990s in the United States.\(^12\)

The reason for the unexpectedly high positive rate observed in children aged 10–14 years is unclear.

<table>
<thead>
<tr>
<th>Age group (yr)</th>
<th>1986</th>
<th>2004</th>
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<tbody>
<tr>
<td></td>
<td>Samples positive/ tested n (%)</td>
<td>OR</td>
</tr>
<tr>
<td>1–14</td>
<td>12/116 (10.3)</td>
<td>1.0*</td>
</tr>
<tr>
<td>15–19</td>
<td>20/126 (15.9)</td>
<td>1.6</td>
</tr>
<tr>
<td>20–29</td>
<td>27/115 (23.5)</td>
<td>2.7†</td>
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</tbody>
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Trend test \( p < 0.01 \) \( p = 0.11 \)

| Total | 59/357 (16.5) | 64/277 (23.1) |

*Adjusted for sex; †statistically significant. OR=odds ratio; CI=confidence interval.
Possible explanations include the existence of a preceding small-scale cluster parvovirus B19 outbreak in that age group. This seems likely because the positive rate in those aged 1–14 years was higher in this study than in the survey done in 1986. However, because the sample size was small, we cannot exclude the possibility of sampling bias. Likewise, the small difference in the seropositive rate of participants aged 1–4 years or 5–9 years was probably because of the small sample size. When we regroup the study participants as shown in Table 29,11 and Figure 1,9,11 the trend is more evident that the positive rate increases with age.

Although parvovirus infection is self-limited in healthy individuals, it is a major threat during pregnancy and is an important cause of early fetal loss. In England, maternal infection with parvovirus B19 is estimated to occur in approximately 1 in 400 pregnancies, and fetal death was estimated to occur in 9% of these cases.18 In the current study, up to 70% of women aged 29 years or less were susceptible to parvovirus B19 infections. Continuous improvements in public and personal hygiene practices should keep the prevalence of parvovirus B19 immunity low. However, because fewer females than males have parvovirus antibodies, as shown in this study, we are concerned about the susceptibility of pregnant women to parvovirus B19 infections and the possible consequences of such infections. Women who work in healthcare settings and daycare centers are at increased risk of acquiring this infection, as are women working in different households.19 Women of childbearing age and obstetric providers are advised to become more familiar with the clinical presentation of a parvovirus B19 infection and its possible consequences.

5. Conclusions

In conclusion, the rate of parvovirus B19 infections in children and young adults was low in Taiwan in the past few decades. People aged ≤30 years are highly susceptible to parvovirus B19 infections. Outbreaks of rash illness in children and young adults should be serologically investigated for parvovirus B19.

Acknowledgments

This study was supported by a grant (DOH96-DC-2039) from the Centers for Disease Control, Department of Health, Taiwan.

References