# The epidemiology of cryptosporidiosis in Victoria, 2001–2009

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## Introduction

Cryptosporidiosis is a protozoan parasitic infection that most commonly presents as gastroenteritis and less commonly infects the respiratory and biliary tracts. Enteric symptoms usually include diarrhoea, bloating, cramping, abdominal pain, vomiting and fever. The disease is usually mild and self-limiting but in immunocompromised individuals is prolonged and can lead to death.[1] The infective dose in humans is low and the incubation period ranges from one to 12 days, with an average of seven days.[1–3] The infectious period lasts from the onset of symptoms, as the oocysts are excreted in the stool, until several weeks after symptoms resolve.[1]

The oocysts are widespread and may remain infective outside the body for two to six months, particularly if the environment is moist. They are highly resistant to standard levels of chemical disinfection of water such as chlorine.[1,3] Outbreaks have been reported in day care centres, and been associated with drinking water, recreational water (waterslides, swimming pools and lakes) and consumption of contaminated beverages.[1,4–12] In Australia, increases in notifications tend to occur in the warmer months and over irregular cycles, with more than 3000 cases notified in Australia in 2002, 2005 and 2006.[13]

Cryptosporidiosis became notifiable in both Australia and Victoria in 2001, with more than 15,000 cases notified between 2002 and 2009. The aim of this study was to describe the epidemiology of notified cases of cryptosporidiosis in Victoria for the period 2001 to 2009 in terms of age, sex, location and season.

## Methods

### Case definition

Cryptosporidiosis is a Group B notifiable disease in Victoria. The Public Health and Wellbeing Regulations 2009 require that medical practitioners and pathology laboratories notify cases to the Department of Health within five days of diagnosis.[14] A confirmed case requires laboratory definitive evidence, the criterion of which is the detection of *Cryptosporidium* spp oocysts.[14]

### Data extraction and manipulation

Confirmed cryptosporidiosis cases with a date or estimated date of illness onset from 1 January 2001 to 31 December 2009 were extracted from the Victorian Department of Health Notifiable Infectious Diseases Surveillance System (NIDS). If no onset date was available the earliest date entered into the system was used. Dates of onset were adjusted by the average incubation period of seven days to provide an estimated date of infection

### Data analysis

#### Descriptive analysis

Data were analysed using Excel and Intercooled STATA version 9.0. Age and region specific rates per 100,000 population were determined using the Australian Bureau of Statistics estimated resident population (ERP) for each year (2001–2008).[15]

#### Statistical analysis

The binomial test was used to examine differences in notifications by sex. The student's t-test was used to test for difference in mean age and univariate analysis of categorical variables was conducted using the chi-squared statistic. Due to over-dispersion of the notifications over time a negative binomial regression, using a log-linear model, was employed to examine whether age, sex and location (region) of cryptosporidiosis notifications differed over time. The outbreak years of 2006 and 2009 were analysed using multinomial logistic regression to identify any differences in age, sex, region and season in the outbreak years compared to non-outbreak years. For all statistical tests a p-value of $<0.05$ was considered significant.

## Results

Between 2001 and 2009, 4,957 cryptosporidiosis cases were notified in Victoria. The largest numbers of cases were notified in 2006 (1,078

cases) and 2009 (1,031 cases). The overall notification rate for Victoria between 2001 and 2009 was 10.9 cases per 100,000 population. The rate of notifications for the two outbreak years (2006 and 2009) was approximately 20 per 100,000 population compared to four to 12 per 100,000 for other years. Over the study period the number of notifications of cryptosporidiosis increased four per cent each year (95 per cent CI 1.03–1.05). This did not change after adjusting for sex, age and location.

The greatest number of notified cases occurred in February, March and April, the warmest months of the year for Victoria (Figure 1). During the study period 2,188 notifications occurred over this three month period.

There were an equal number of notifications for males and females and this did not change over time (95 per cent CI 0.98–1.09). The mean age was 17.7 years for males and 22.7 years for females (p<0.001). Forty eight per cent of cryptosporidiosis cases were in children aged less than 10 years, at a rate of 40.7 per 100,000 population compared to 6.5 per 100,000 for those aged 10 years and older.

Among children, the largest proportion of notifications was in those aged two years and younger (18 to 30 per cent of the total cryptosporidiosis notifications per year). The age specific notification rate showed a bimodal distribution, peaking at two years and younger and at 30 to 34 years for females and 35 to 39 years for males (Figure 2). The highest age and sex specific notification rate was for males aged two years or less(68 cases per 100,000 population) compared with 52.9 per 100,000 population for females in the same age group (Figure 2).

**Figure 1: Notified cases of cryptosporidiosis by month, Victoria, 2001–2009**

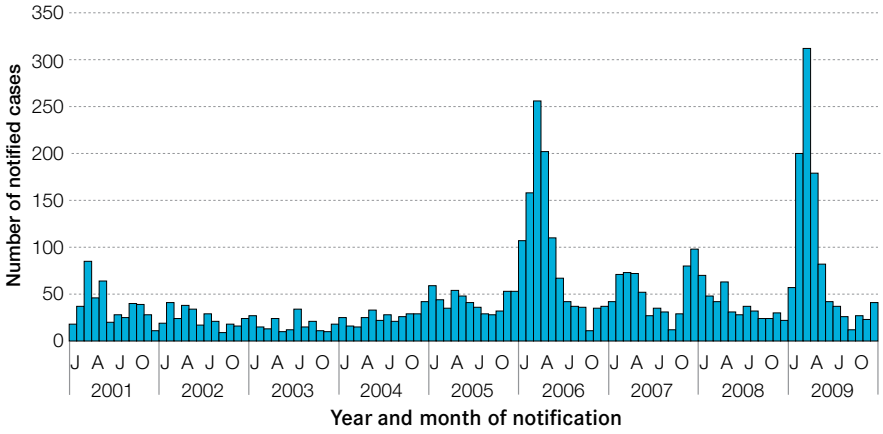



**Figure 2: Notification rate of cryptosporidiosis by age group, Victoria, 2001–2009**

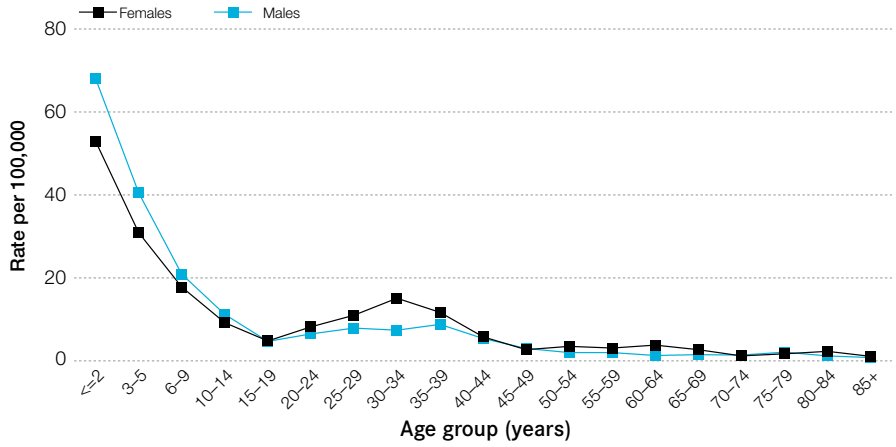
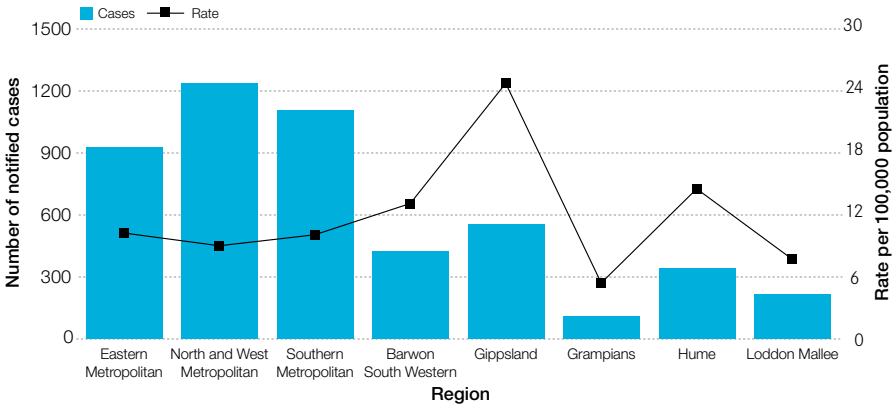



**Figure 3: Notifications of cryptosporidiosis, by region and rate per 100,000, Victoria, 2001–2009**




Two-thirds of cryptosporidiosis notifications (3,273) occurred in metropolitan regions. North and West (25.2 per cent) and Southern (22.6 per cent) Metropolitan Regions each had a larger proportion of total notifications than Eastern Metropolitan Region (18.9 per cent). Of the rural regions, Gippsland had the highest number of notifications, with the next highest number in Barwon South Western. The lowest number of notified cases occurred in the Grampians Region, followed

by Loddon Mallee. The region with the highest rate of cryptosporidiosis was Gippsland (24.9 per 100,000), followed by Hume (14.7 per 100,000) and Barwon South Western (13.3 per 100,000). Rates between metropolitan regions were comparable (around 10 per 100,000 for each) (Figure 3).

Multiple regression analysis indicated that in the outbreak years of 2006 and 2009, the odds of being notified with cryptosporidiosis were significantly higher for those aged 20 years and over, those residing in metropolitan regions and during autumn compared with non-outbreak year notifications. The odds were significantly lower for cases occurring in spring and there was no difference by gender (Table 1).

**Table 1: Multivariate logistic regression model: comparison between notifications from outbreak years and notifications from non-outbreak years, Victoria 2001–2009**

| Characteristic* (n=3,395) | Outbreak years (per cent) | Non-outbreak years ( per cent) | OR (95%CI) Outbreak years vs non-outbreak years | p value |
|---|---|---|---|---|
| **Sex** | | | | **0.384** |
| Male | 557 (33.5) | 1,106 (66.5) | 1.0 | |
| Female | 630 (36.4) | 1,102 (63.6) | 1.1 (0.9–1.2) | |
| **Age group** | | | | **<0.001** |
| 0–9 | 406 (28.0) | 1,046 (72.0) | 1.0 | |
| 10–19 | 132 (32.6) | 273 (67.4) | 1.2 (1.0–1.6) | |
| 20–39 | 389 (40.4) | 574 (59.6) | 1.6 (1.4–1.9) | |
| 40+ | 260 (45.2) | 315 (54.8) | 2.0 (1.6–2.4) | |
| **Region** | | | | **<0.001** |
| Rural | 387 (28.6) | 965 (71.4) | 1.0 | |
| Metropolitan | 800 (39.2) | 1,243 (60.8) | 1.4 (1.2–1.6) | |
| **Season** | | | | **<0.001** |
| Summer | 335 (34.6) | 632 (65.4) | 1.0 | |
| Autumn | 524 (45.1) | 639 (54.9) | 1.5 (1.3–1.8) | |
| Winter | 200 (30.2) | 463 (69.8) | 0.9 (0.7–1.1) | |
| Spring | 128 (21.3) | 474 (78.7) | 0.5 (0.4–0.7) | |

* Notifications with missing values for any of the variables were excluded

## Discussion

This report describes the epidemiology of cryptosporidiosis in Victoria in the first nine years since the disease became notifiable in 2001. The large number of cases found in 2006 and 2009 illustrates the interannual nature of cryptosporidiosis in Victoria which has also been observed in other Australian jurisdictions.[16–19] Despite these peak years, the number of notifications in Victoria increased over this time, by four per cent per year. There were no overall differences by sex, and the highest notification rates were among infants and children (zero to nine years), peaking with the zero to two year age group.

The bimodal age distribution of cryptosporidiosis notifications may be attributed to the susceptibility of children to infection and their tendency to visit the doctor more regularly, thereby increasing the chance of being diagnosed and notified.[20] It is not clear why the notification rate for males in this age group is higher than the rate for females. A possible explanation could be differences in immunity between the two genders.[21] The second mode was for adults aged 30 to 39 years, particularly women. This age group may be more likely to be parents of infected children. Notifications may be higher in this group for two reasons: an increased likelihood of disease transmission from child to parent, and an increased likelihood of diagnosis in adults attending the doctor with a sick child.

During late summer and early autumn the largest number of notifications was found in the metropolitan regions; this is not unexpected as these regions have the largest proportion of the Victorian population. One explanation of this seasonal increase is increased waterborne recreation activities during this time; a known risk factor for cryptosporidiosis.[4–6,9] Increased recreational water activities in the summer months may also explain the high rates in the zero to two year age group, as they may be more likely to attend swimming pools for lessons or recreational use.[22]

During the cooler months of winter and spring the largest numbers of notifications were found in the rural regions of Gippsland and Barwon South Western. Farming practices including calving of large mammals such as cattle and sheep may lead to increased rates at this time of the year in these areas.[23] Large numbers of notifications were also observed in the warmer months in these areas; these are large tourism areas that promote water sports activities in the summer. A mixture of exposures could be at play here.

Multivariate analysis showed that during outbreak years adults were more likely to be notified with cryptosporidiosis. This finding was unexpected as this is different to the usual pattern of cryptosporidiosis among infants and children discussed above. The finding that metropolitan areas were more likely to have notifications during autumn was not unexpected. Information on risk factors is not routinely entered into NIDS so it is difficult to establish the reasons for this. It may be due to

increased waterborne recreational activities by adults during unusually warmer times during the study period.

## Conclusion

In Victoria, between 2001 and 2009, the highest rate of cryptosporidiosis notifications was among infants and children, except during the outbreak years, where adults were more likely to be notified. The greatest number of notifications occurred in metropolitan areas during late summer/early autumn. In the rural regions, Gippsland and Barwon South Western, the largest number of notifications were in late winter/early spring and late summer/early autumn suggesting dual risk factors. Policies are being developed to guide the Environmental Health Unit of the Department of Health in the environmental investigation of outbreaks. An early warning system needs to be developed to pre-empt outbreaks during high risk periods, in order to minimise their progression.

## Acknowledgements

The authors would like to thank the staff of the Communicable Disease Prevention and Control Unit for assistance provided in this analysis.

Lillian Kent is a Master of Applied Epidemiology (MAE) scholar at the National Centre for Epidemiology and Population Health, at The Australian National University. The MAE program is funded by the Australian Government Department of Health and Ageing.

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