Severe weather events linked to outbreaks of crypto in Aotearoa – New study

27 May 2024

Leah Grout, Simon Hales, Michael Baker, Nigel French, Marnie Prickett, Nick Wilson

Summary

In this Briefing we summarise findings from our recent study into the link between severe weather events and clusters of the gastrointestinal disease cryptosporidiosis in Aotearoa New Zealand (NZ). We found statistical evidence that weather events with heavy rainfall or flooding may play a role in the development of some outbreaks of this infectious disease. This finding is consistent with other NZ and international evidence, though additional research is needed to further clarify this relationship. This is especially so since rainfall intensity is expected to keep rising in NZ due to climate change. This study provides yet further support for the need to protect drinking water supplies and recreational water from contamination with pathogens, especially from agricultural runoff and sewage leaks from broken pipes. The Government's current plans to weaken drinking water protections should be discouraged.

Cryptosporidium are microscopic parasites that can cause gastrointestinal pain, diarrhea, vomiting and fever with symptoms usually lasting one to two weeks. They are common cause of waterborne outbreaks of infectious intestinal disease in NZ.[1]

In NZ, *Cryptosporidium* infections (cryptosporidiosis) in people have been linked to rainfall[2-4] and temperature.[2 3 5] Heavy rainfall events can increase surface runoff of *Cryptosporidium* in the environment,[6-9] and such events have been linked to higher *Cryptosporidium* pathogen loads in waterways and increased infection rates.[10-12] Runoff due to heavy rainfall could increase the risk related to the consumption of untreated drinking water, and higher infection rates have been reported in areas with untreated or inadequate drinking water supplies in NZ.[13] In addition, *Cryptosporidium* are resistant to conventional water treatment techniques[14] and increased pathogen loading due to heavy rainfall events can overwhelm drinking water and wastewater infrastructure and lead to disease outbreaks.[15] Recreational water contact, such as swimming, has also been identified as an important risk factor for infection.[5] The Government is planning to weaken protections for water, including drinking water. In an announcement in April 2024 on changes to the Resource Management Act, the Government reiterated its plan to deprioritise drinking water protections by changing Te Mana o te Wai framework.[16]

Clusters of *Cryptosporidium* infections in NZ

In our just published study,[17] we identified a total of 15,822 cases of cryptosporidiosis that were reported in NZ from 1997 to 2015. Sixty-five clusters were detected using statistical methods during that period, and 38 (58.5%) of those clusters were statistically significant, meaning that they were unlikely to have occurred by chance. Approximately 4% (645/15,822) of reported cases from 1997 to 2015 were part of significant clusters. The number of cases in the significant clusters ranged from three to 83 (mean = 17.0, median = 10).

Comparison to severe weather events

The average incubation period for cryptosporidiosis is around seven days.[18-21] However, *Cryptosporidium* can survive in the environment for more than 12 weeks.[22] Therefore, we searched the National Institute of Water and Atmospheric Research (NIWA) Historic Weather Events Catalogue for severe weather events with increased rainfall in the 21 days before each of the significant detected clusters. We found that around one third (34.2%, 13/38) of the statistically significant clusters occurred at places and times that aligned with severe weather events from NIWA's Catalogue. Figure 1 shows the locations of statistically significant clusters of cryptosporidiosis that aligned with severe weather events in NZ.

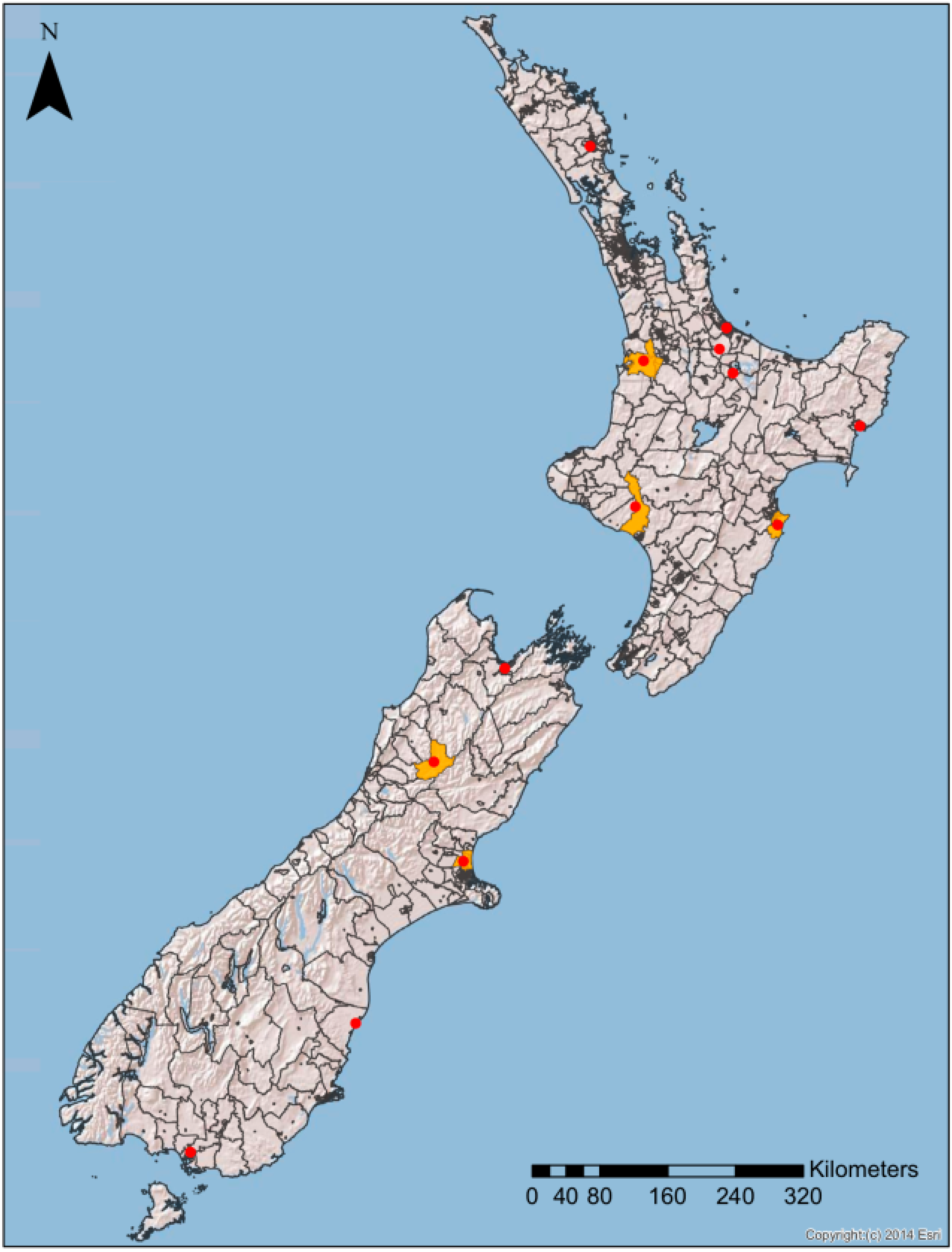

Figure 1. Clusters of cryptosporidiosis in NZ (1997-2015) at the census area unit (CAU) level that align temporally and spatially with severe weather events. The orange regions (with red dots at the CAU centroids) are CAUs with statistically

significant clusters (p<0.05).

Nearly half (46.2%, 6/13) of the 13 clusters that aligned with severe weather events occurred in the spring, three occurred in the winter, three occurred in autumn, and one occurred in late summer and early autumn. Clusters detected during spring months may be related to spring calving and lambing, because newborn livestock can be an important source of cryptosporidiosis.[23-25]

Research and policy implications

This study found that heavy rainfall and flooding events occurred before several detected clusters of cryptosporidiosis in NZ. However, additional research is required to better determine the role of extreme weather events on rates of infectious intestinal diseases. There is an urgent need for such research as rainfall intensity is expected to keep rising in NZ due to climate change.[26 27]

This study also supports the need to further protect drinking water supplies from contamination with pathogens, especially from agricultural runoff and sewage. Cases and outbreaks of cryptosporidiosis, as well as other infectious intestinal diseases, have been regularly linked to contaminated water supplies.[28-30] For example, the 2023 waterborne Queenstown cryptosporidiosis outbreak was likely due to human faecal contamination of water supplies and resulted in at least 72 confirmed cases.[31 32] Additionally, the 2016 waterborne Havelock North campylobacteriosis outbreak was attributed to the contamination of two untreated bore wells with sheep faeces, and resulted in approximately 7570 cases and four deaths.[33] Such outbreaks highlight the need to strengthen source protection of water supplies and for a strong regulatory framework that prevents water pollution from livestock agriculture and inadequate water infrastructure (which was a major conclusion of the Government Inquiry into the Havelock North Drinking Water[34]).

Conclusions

This study provides additional evidence that extreme weather events can play a role in outbreaks of cryptosporidiosis in NZ. Additionally, 46.2% of the clusters that aligned with severe weather events occurred in the spring and may be linked to calving and lambing. Additional research is needed to better assess the role of heavy rainfall and other environmental factors, such as livestock farming and inadequate water infrastructure, in cryptosporidiosis cases and outbreaks, especially as rainfall intensity is expected to keep increasing in NZ due to climate change. This research highlights the need for drinking water safety and water quality to be prioritized in policy to protect public health. The Government should be discouraged from its plans to weaken protections for water.

What this Briefing adds

- We report on our just published study that provides additional scientific evidence that extreme weather events can play a role in outbreaks of cryptosporidiosis in NZ.
- These new findings are put into context with other NZ and international

evidence that heavy rainfall events can increase surface runoff of *Cryptosporidium* in the environment, are linked to higher *Cryptosporidium* pathogen loads in waterways and increased infection rates in humans.

Implications for policy and practice

- More research is needed in NZ to better understand the relationship between severe weather events and risk of enteric diseases such as cryptosporidiosis, especially as climate change intensifies.
- The importance of source water protection is particularly relevant in this case as *Cryptosporidium* are resistant to conventional water treatment techniques. However, the Government is planning to weaken protections for source water.
- Similarly, protection of recreational water from agricultural run-off and human faecal contamination, as well as investment in water and wastewater infrastructure, may reduce cases of cryptosporidiosis arising from swimming and other contact with recreational water.

Author details:

Assoc Prof Leah Grout, Southern California University of Health Sciences, USA

Prof Simon Hales, Department of Public Health, University of Otago Wellington, and Public Health Communication Centre

Prof Michael Baker, Department of Public Health, University of Otago Wellington, and Public Health Communication Centre

Prof Nigel French, Distinguished Professor of Infectious Disease Epidemiology and Public Health at Massey University

Marnie Prickett, Department of Public Health, University of Otago Wellington, and Public Health Communication Centre

Prof Nick Wilson, Department of Public Health, University of Otago Wellington, and Public Health Communication Centre

References

1. ESR. Annual summary of outbreaks in New Zealand 2016 [Client Report FW17038]. Institute of Environmental Science and Research Ltd. (ESR). 2018. Available from: https://surv.esr.cri.nz/surveillance/annual_outbreak.php?we_objectID=4741.
2. Lal A, Ikeda T, French N, et al. Climate variability, weather and enteric disease incidence in New Zealand: Time series analysis. *PLoS One* 2013;8(12). doi: 10.1371/journal.pone.0083484
3. Britton E, Hales S, Venugopal K, et al. The impact of climate variability and change on cryptosporidiosis and giardiasis rates in New Zealand. *Journal of Water and Health* 2010;8(3):561. doi: 10.2166/wh.2010.049
4. Lal A, Lill AWT, McIntyre M, et al. Environmental change and enteric zoonoses in New

Zealand: a systematic review of the evidence. *Australian and New Zealand Journal of Public Health* 2015;39(1):63-68. doi: 10.1111/1753-6405.12274

5. Lake IR, Pearce J, Savill M. The seasonality of human cryptosporidiosis in New Zealand. *Epidemiology and Infection* 2008;136(10):1383-1387. doi: 10.1017/S0950268807009922
6. Davies CM, Ferguson CM, Kaucner C, et al. Dispersion and transport of Cryptosporidium oocysts from fecal pats under simulated rainfall events. *Applied and Environmental Microbiology* 2004;70(2):1151. doi: 10.1128/AEM.70.2.1151-1159.2004
7. Davies-Colley R, Nagels J, Lydiard E. Stormflow-dominated loads of faecal pollution from an intensively dairy-farmed catchment. *Water Science and Technology* 2008;57(10):1519-23. doi: 10.2166/wst.2008.257
8. Tryland I, Robertson L, Blankenberg A-G, et al. Impact of rainfall on microbial contamination of surface water. *International Journal of Climate Change Strategies and Management* 2011;3(4):361-73. doi: 10.1108/17568691111175650
9. Lal A, Baker MG, Hales S, et al. Potential effects of global environmental changes on cryptosporidiosis and giardiasis transmission. *Trends in Parasitology* 2013;29:83-90. doi: 10.1016/j.pt.2012.10.005
10. Lake IR, Bentham G, Kovats RS, et al. Effects of weather and river flow on cryptosporidiosis. *Journal of Water and Health* 2005;3(4):469-74. doi: 10.2166/wh.2005.048
11. Curriero F, Patz J, Rose J, et al. The association between extreme precipitation and waterborn disease outbreaks in the United States, 1948-1994. *American Journal of Public Health* 2001;91(8):1194-9. doi: 10.2105/AJPH.91.8.1194
12. Young I, Smith BA, Fazil A. A systematic review and meta-analysis of the effects of extreme weather events and other weather-related variables on Cryptosporidium and Giardia in fresh surface waters. *Journal of Water and Health* 2015;13(1):1-17. doi: 10.2166/wh.2014.079
13. Duncanson M, Weinstein P, Chang W, et al. Cryptosporidiosis: Drinking water quality and other risk factors in Aotearoa New Zealand *Epidemiology* 2003;14(Supplement):S129-S30. doi: 10.1097/00001648-200309001-00318
14. Coffey R, Bergin D, Cummins E. Use of meta-analysis to assess the effect of conventional water treatment methods on the prevalence of Cryptosporidium spp. in drinking water. *Human and Ecological Risk Assessmen: An International Journal* 2010;16(6):1360-78. doi: 10.1080/10807039.2010.526505
15. Lal A. Evaluating the environmental and social determinants of enteric disease in New Zealand [Doctoral Thesis]. Department of Public Health, University of Otago, Wellington; 2014. Available from: https://ourarchive.otago.ac.nz/handle/10523/4813.
16. Government reveals first changes to Resource Management Act. *Radio New Zealand,* 23 April 2024. Available from: https://www.rnz.co.nz/news/political/514993/government-reveals-first-changes-to-resource-management-act (accessed 30 April 2024).
17. Grout L, Hales S, Baker MG, et al. Severe weather events and cryptosporidiosis in Aotearoa New Zealand: A case series of space-time clusters. *Epidemiology and Infection* 2024;152:e64. doi: 10.1017/S095026882400058X
18. Gupta M, Haas CN. The Milwaukee Cryptosporidium outbreak: assessment of incubation time and daily attack rate. *Journal of Water and Health* 2004;2(2):59-69. doi: 10.2166/wh.2004.0006
19. Jokipii L, Jokipii AMM. Timing of Symptoms and Oocyst Excretion in Human Cryptosporidiosis. *The New England Journal of Medicine* 1986;315(26):1643-47. doi: 10.1056/NEJM198612253152604
20. Mac Kenzie WR, Schell WL, Blair KA, et al. Massive Outbreak of Waterborne

Cryptosporidium Infection in Milwaukee, Wisconsin: Recurrence of Illness and Risk of Secondary Transmission. *Clinical Infectious Diseases* 1995;21(1):57-62. doi: 10.1093/clinids/21.1.57
21. Horne S, Sibal B, Sibal N, et al. Cryptosporidium outbreaks: identification, diagnosis, and management. *British Journal of General Practice* 2017;67(662):425-26. doi: 10.3399/bjgp17X692501
22. Olson ME, Goh J, Phillips M, et al. Giardia Cyst and Cryptosporidium Oocyst Survival in Water, Soil, and Cattle Feces. *Journal of Environmental Quality* 1999;28(6):1991-96. doi: 10.2134/jeq1999.00472425002800060040x
23. Snel SJ, Baker MG, Kamalesh V, et al. A tale of two parasites: the comparative epidemiology of cryptosporidiosis and giardiasis. *Epidemiology and Infection* 2009;137(11):1641-50. doi: 10.1017/S0950268809002465
24. Learmonth J, Ionas G, Pita A, et al. Seasonal shift in Cryptosporidium parvum transmission cycles in New Zealand. *Journal of Eukaryotic Microbiology* 2001:34S-35S.
25. Grinberg A, Pomroy W, Weston J, et al. The occurrence of Cryptosporidium parvum, Campylobacter and Salmonella in newborn dairy calves in the Manawatu region of New Zealand. *New Zealand Veterinary Journal* 2005;53(5):315-20. doi: 10.1080/00480169.2005.36566
26. Lawrence J, Mackey B, Chiew F, et al. Chapter 11: Australasia. In: Hoegh-Guldberg O, Wratt D, eds. IPCC WGII Sixth Assessment Report. Geneva: Intergovernmental Panel on Climate Change (IPCC), 2021.
27. Fischer EM, Knutti R. Anthropogenic contribution to global occurrence of heavy-precipitation and high-temperature extremes. *Nature Climate Change* 2015;5(6):560-64. doi: 10.1038/nclimate2617
28. McDaniel CJ, Cardwell DM, Moeller RB, et al. Humans and cattle: A review of bovine zoonoses. *Vector Borne and Zoonotic Diseases* 2014;14(1):1-19. doi: 10.1089/vbz.2012.1164
29. Cavirani S. Cattle industry and zoonotic risk. *Veterinary Research Communications* 2008;32 (Suppl 1):S19-24. doi: 10.1007/s11259-008-9086-2
30. Castro-Hermida JA, Garcia-Presedo I, Almeida A, et al. Detection of Cryptosporidium spp. and Giardia duodenalis in surface water: a health risk for humans and animals. *Water Research* 2009;43(17):4133-42. doi: 10.1016/j.watres.2009.06.020
31. Queenstown cryptosporidium outbreak: Four more weeks of boiling water. *Radio New Zealand,* 14 November 2023. Available from: https://www.rnz.co.nz/news/national/502386/queenstown-cryptosporidium-outbreak-four-more-weeks-of-boiling-water (accessed 30 April 2024).
32. Baker MG, Prickett M, Pourzand F, et al. Queenstown outbreak highlights future challenges for clean drinking water. The Briefing: Public Health Communication Centre Aotearoa, 29 September 2023.
33. Gilpin BJ, Walker T, Paine S, et al. A large scale waterborne Campylobacteriosis outbreak, Havelock North, New Zealand. *Journal of Infection* 2020;81(3):390-95. doi: 10.1016/j.jinf.2020.06.065
34. Government Inquiry into Havelock North Drinking Water. Report of the Havelock North Drinking Water Inquiry: Stage 2. Auckland, New Zealand, 2017.

Public Health Expert Briefing (ISSN 2816-1203)

Source URL:
https://www.phcc.org.nz/briefing/severe-weather-events-linked-outbreaks-crypto-aotearoa-new-study