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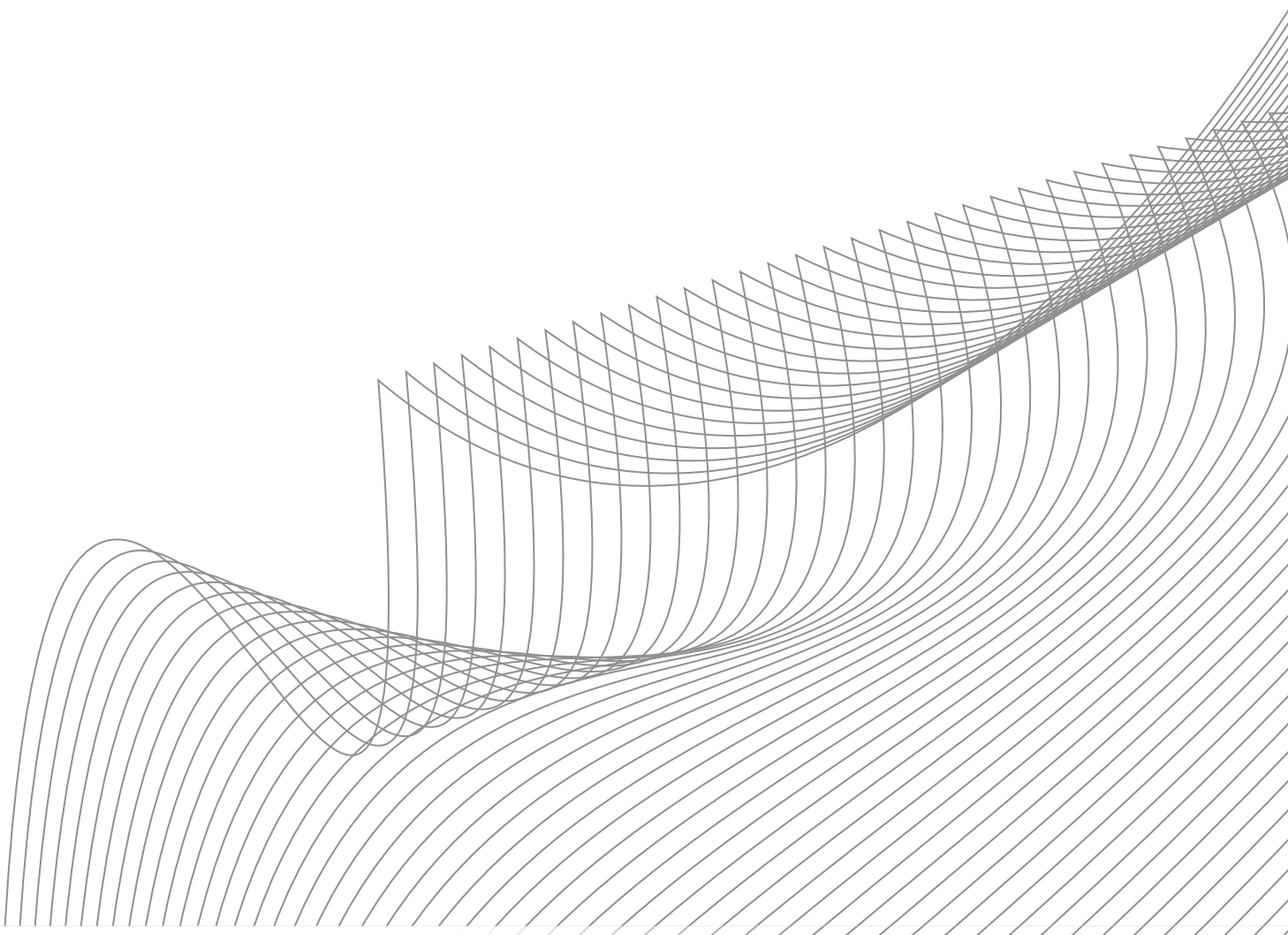

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Original article

Donuts for weight loss? A norovirus outbreak associated with a bakery in the Australian Capital Territory

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Abstract

Background

An outbreak of gastroenteritis was investigated following complaints of illness after eating donuts from a food premises in the Australian Capital Territory (ACT).

Methods

Food poisoning complainants and contacts were surveyed using a standard gastroenteritis questionnaire including menu items from the food premises. Descriptive analyses were performed on data collected for all responses. A case-control study was conducted for a group of 140 people at a catered function. Food safety inspections were conducted with food and environmental samples tested at the ACT Government Analytical Laboratory. Stool specimens were collected from cases who were ill at the time of interview. Neither active case finding, nor viral testing of food or environmental samples, could be conducted.

Results

Three hundred and one people were surveyed, and 215 individuals (71.4%) reported vomiting and/or diarrhoea following consumption of a donut purchased from the business over a five-day period. All ill respondents reported eating a donut. The medians of incubation period and illness duration were 34 hours (interquartile range, IQR: 29–42 hours) and 48 hours (IQR: 29–72 hours) respectively. Diarrhoea, vomiting and abdominal pain were the most commonly reported symptoms. Eight out of 11 specimens collected from ill individuals were positive for norovirus.

For the case-control study, data from 59 attendees were collected, with an attack rate of 46% (27/59). Eating any kind of filled donut was associated with a person becoming ill (odds ratio: 10.4; 95% confidence interval: 1.18–478.13). No single flavour was identified as the likely source of infection.

Elevated levels of coliforms were present in two samples of donut filling obtained during the food safety inspection.

Conclusion

Donuts are a novel vehicle for norovirus infection. This implicated pathogen, plus evidence collected at the food premises suggestive of faecal contamination, indicates the source of this outbreak was likely an ill food handler. The findings of this outbreak highlight the importance of excluding food

handlers from work while ill. While this was one of the largest foodborne outbreaks investigated in the ACT, the true extent of illness remains unknown. Active case finding should be pursued to determine the magnitude of outbreaks.

Keywords: outbreak; foodborne disease; gastroenteritis; norovirus; food handling; case-control study; donuts

Introduction

Foodborne gastrointestinal illness places a significant burden on the health of Australians, with an estimated 4.1 million cases occurring each year.[1] Norovirus is estimated to be the most common cause of gastroenteritis illness in Australia.[1] This highly infectious pathogen often transmits person-to-person but can also spread through contact with contaminated surfaces and foods. This report describes an outbreak of norovirus infection associated with consumption of donuts, a novel vehicle for foodborne illness in Australia.

On 25 November 2021, the Australian Capital Territory Department of Health (ACT Health) received notice from the proprietor of a food premises that they had received a report from a patron of illness occurring among eleven people following consumption of donuts. The food premises primarily sold donuts made onsite, with additional baked good products, including tarts and flans which were sold at the premises, purchased wholesale and made offsite. Separately, ACT Health received two additional reports of illness on the same day for the same food premises. Initial interviews with complainants and their contacts found that they had all eaten donuts from the food premises 24 to 48 hours before becoming unwell. An outbreak investigation was initiated to identify the cause of illness and to apply appropriate public health actions to prevent further cases.

Methods

Epidemiological investigation

Active case finding was not able to be conducted for this outbreak as most orders were reportedly from walk-in customers; the food premises denied keeping records of orders; and no public alerts were issued by ACT Health. This investigation therefore relied on passive case finding from complainants contacting ACT Health and identifying contacts who shared meals with them.

A case was defined as a person who reported diarrhoea and/or vomiting to ACT Health following the consumption of a donut purchased from the food premises from 20 November to 24 November 2021 inclusive.

Complainants and their contacts were sent an online questionnaire, developed in REDCap[2,3] using a standard gastrointestinal outbreak questionnaire, adapted to the menu of the food premises. Complainants and contacts who required translation services, or who could not otherwise complete the online questionnaire, were interviewed via phone using the same REDCap questionnaire. Non-respondents were contacted up to three times before being considered lost to follow up.

Interview data was stored in REDCap and analysis was performed in R version 4.04.[4]

A descriptive analysis was conducted for all respondents. An analytical study could not be conducted for the overall community-wide outbreak, as sufficient controls could not be recruited through passive case finding. A case-control study was conducted for the largest cohort identified among respondents, a catered function at an ACT workplace held on 24 November 2021. The REDCap questionnaire was distributed by the workplace, on behalf of ACT Health, to all attendees of this function. A case-control study was conducted rather than a cohort study as it was unclear if respondents were representative of the event attendees.

Univariate analysis included calculating odds ratios (OR) for donuts consumed, by filling type and by flavour.

This investigation is covered by the Australian National University Human Research Ethics Committee standing approval for outbreak investigations involving staff and students (Protocol 2017/909) and formed part of a public health response under the ACT *Public Health Act 1997.*

Environmental investigation

Environmental health officers from ACT Health attended the food premises on 25 November 2021 to conduct a food inspection, to interview the proprietor of the food premises and to collect food and environmental samples under the ACT *Food Act 2001*. An additional interview with the proprietor was conducted on 6 December 2021 to discuss laboratory results and food preparation procedures.

Laboratory investigation

Eleven stool specimens were collected from cases. Stool specimens were tested at private or public hospital laboratories for common bacterial and viral pathogens by polymerase chain reaction (PCR) and/or by culture. Three clinical laboratories tested stool specimens for viral pathogens. Antigen tests were performed using the R-Biopharm® RIDA®QUICK assay. PCR testing was conducted using the Cepheid® GeneXpert® or the Seegene Allplex TM GI-Virus assay.

Food and environmental samples were tested at the ACT Government Analytical Laboratory (ACTGAL). Six samples of various donut fillings were tested for *Salmonella* spp., *Listeria monocytogenes*, *Escherichia coli*, standard plate count (SPC), *Clostridium perfringens*, coagulase-positive *Staphylococcus* spp., *Bacillus cereus,* and coliforms. Results were interpreted following best practice guidance from the Food Standards Australia New Zealand (FSANZ).[5]

Seventeen environmental samples collected included a piping bag and swabs from kitchen surfaces and mixing equipment. Seven swabs and the piping bag were tested for *L. monocytogenes* detection and ten swabs were tested for *Salmonella* spp. detection. The method used for environmental sample analysis requires the whole item to be submerged in culture media specific to the target organism. As a result, only one organism may be tested from each swab/item.

No viral testing was conducted for food or environmental samples as ACTGAL does not have the capabilities to test for viral pathogens in food and environmental samples.

Results

Epidemiological investigation

Descriptive analysis

The total number of patrons who consumed donuts in the study period was unknown. A total of 301 individuals were interviewed or surveyed as part of this outbreak; 71% of respondents (215/301) met the case definition. A further 16 individuals (5%; 16/301) reported a milder illness without vomiting and/or diarrhoea and did not meet the case definition.

The median age of respondents was 33 years (range: 3–91 years; interquartile range, IQR: 27–41 years) and 53% (159/301) were female. The median age (32 years for ill respondents, 34 for non-ill respondents) and sex (52% female for ill respondents, 55% female for non-ill respondents) of respondents were similar between ill and non-ill respondents.

The most commonly reported symptoms were diarrhoea (89%; 191/215); vomiting (85%; 182/215); nausea (74%; 159/215) and abdominal pain (72%; 155/215). Eight cases (4%; 8/215) reported the presence of blood in stool. Two cases were hospitalised for their illness.

The median incubation period for all ill respondents was 34 hours (range: 9–112 hours; IQR: 29–42 hours) and the median illness duration was 48 hours (range: 4–150 hours; IQR: 29–72 hours).

All interviewed or surveyed patrons ate food purchased from the premises between 20 November and 24 November 2021 inclusive. All 215 cases reported eating a donut from the food premises. Most cases became unwell between the late hours of 21 November and 22 November 2021 (Figure 1).

One case had an illness onset on 20 November 2021, which was the same day as consumption. This case was hospitalised for their illness and had previously received gastric sleeve surgery. This medical history was considered to be a potential characteristic increasing a person's susceptibility to infection, and the case was included in this analysis.

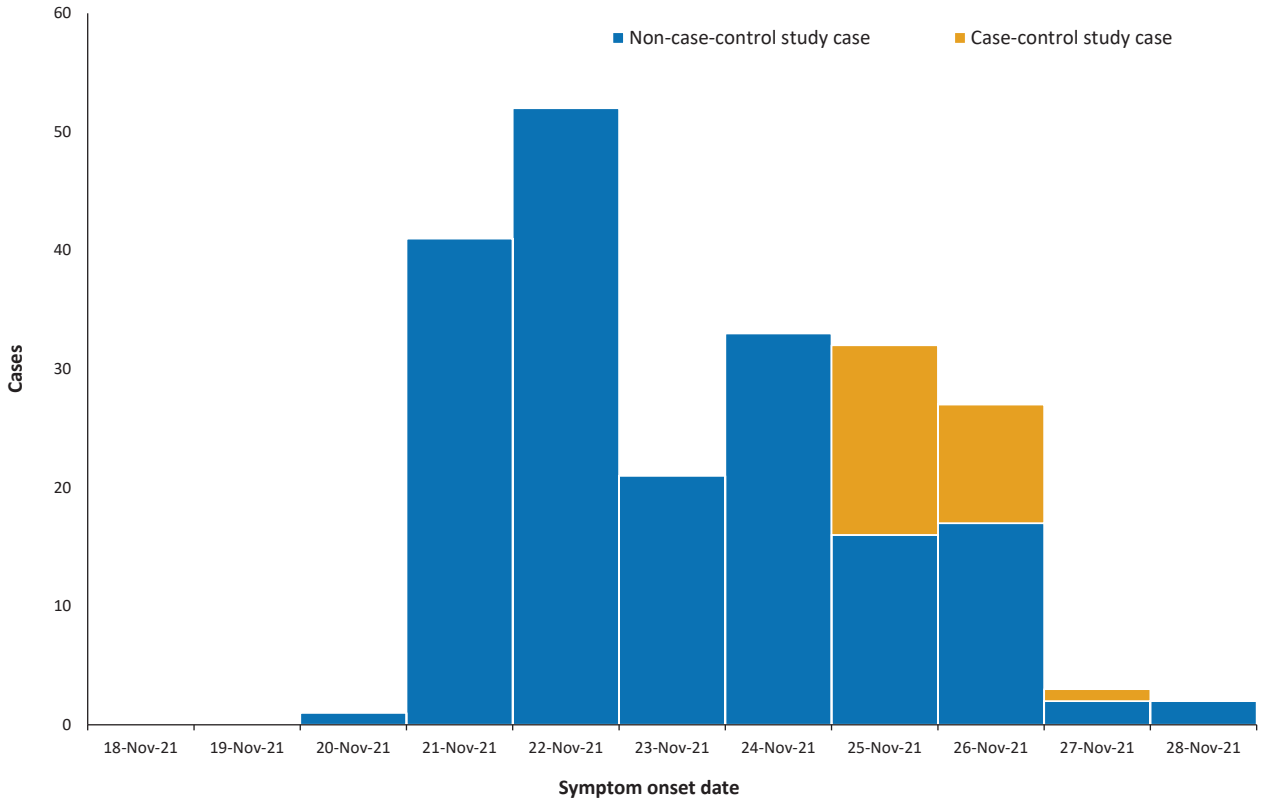
Eight cases had an incubation period of 96 hours or more. All eight of these cases had at least one other member of their household who was a case and had an earlier illness onset. These cases were likely infected by secondary transmission from a household contact, rather than from a food source.

Case-control study

The catered function included 192 donuts prepared the day of the function and included a mix of filled and unfilled donuts. The event was attended by 140 people who had not shared a meal in the week prior, and no other food products were served.

Of the 140 attendees at the workplace function, 59 individuals (42%) completed the questionnaire. Almost half of respondents (46%; 27/59) met the case definition, and a further four individuals reported a milder illness without vomiting and/or diarrhoea and were not considered as cases in this analysis. These four cases were excluded in this analysis. The remaining sample of 55 respondents were included.

Figure 1: Epidemic curve of symptom onset date of cases, by general investigation and case-control study, norovirus outbreak, Australian Capital Territory, November 2021



The median age of study participants was 37 years (range: 28–50 years; IQR: 34–39 years) and 35% of participants were female. There were no statistically significant differences in age (test $t = 1.25$; p-value = 0.22) or sex (test chi-squared = 1.74; p-value = 0.19) between cases and controls in the study.

The median incubation period for cases in the case-control study was 35 hours (range: 13–71 hours; IQR: 31–46 hours) and the median illness duration was 39 hours (range: 4–87 hours; IQR: 22–66 hours).

Attendees ate a wide variety of donut flavours at the catered function (Table 1). No single flavour was statistically associated with illness. The only statistically significant association was found between eating any kind of filled donut and a person becoming unwell; however, the confidence interval (CI) for this association was wide (OR:10.40; 95% CI: 1.18–478.73).

Table 1: Summary of attack rates and odds ratios for donuts, by filling type and the most commonly eaten flavours at a catered function,[a] 24 November 2021

Exposures	Cases			Controls			OR	95% CI
	Number	Total	%	Number	Total	%		
Donut filling type								
Any filled donut	26	27	96.3%	20	28	71.4%	10.40	1.18–478.73
Any cream/custard filled donut	15	27	55.6%	12	28	42.9%	1.67	0.51–5.53
Any caramel/jam/Nutella filled donut	7	27	25.9%	8	28	28.6%	0.86	0.22–3.38
Any unfilled donut	5	27	18.5%	3	28	10.7%	1.89	0.32–13.46
Most frequently consumed donut flavours								
Nutella[b]	4	27	14.8%	5	28	17.9%	0.80	0.14–4.27
Vanilla custard[c]	4	27	14.8%	3	28	10.7%	2.26	0.29–26.80
Dark chocolate mousse[c]	0	27	0.0%	3	28	10.7%	N/A[d]	N/A
Crème Brûlée[c]	1	27	3.7%	3	28	10.7%	0.32	0.01–4.38
Salted caramel[b]	3	27	11.1%	1	28	3.6%	3.38	0.25–183.59
Cookies and cream[c]	2	27	7.4%	1	28	3.6%	2.16	0.10–132.06
Cream and jam[b,c]	2	27	7.4%	1	28	3.6%	2.16	0.10–132.06
Jam[b]	1	27	3.7%	2	28	7.1%	0.50	0.01–10.28
Biscoff milky bar gold[c]	2	27	7.4%	1	28	3.6%	2.16	0.10–132.06
Tiramisu custard[c]	2	27	7.4%	0	28	0.0%	N/A	N/A
Oreo cheesecake[c]	1	27	3.7%	1	28	3.6%	1.04	0.13–84.49
Cotton candy custard[c]	1	27	3.7%	1	28	3.6%	1.04	0.13–84.49
Boston cream[c]	1	27	3.7%	1	28	3.6%	1.04	0.13–84.49
Pistachio[c]	1	27	3.7%	1	28	3.6%	1.04	0.13–84.49

a Only flavours reported to have been eaten by two or more participants are included.

b Donut has a pre-bought Nutella, salted caramel, or jam filling.

c Donut has a cream/custard filling made at the food premises.

d N/A: not applicable.

Environmental investigation

Environmental health officers collected six food samples during their inspection on 25 November 2021, including custard fillings, cream filling, and icing. No ready-for-sale donuts, filled or otherwise, were available for sampling. No food was being prepared at the time of the inspection, so hand hygiene and food preparation techniques could not be observed. Seventeen environmental samples were collected, including a reusable piping bag and swabs of surfaces.

Food handlers had designated activities during preparation, with separate staff for baking steps such as dough preparation and frying, and one staff member for decorating, including custard or filling preparation, piping fillings, and icing donuts. Dough making was kept separate from other activities in the premises, in separate mixing bowls. Proving and cooking of donuts were automated. All donut flavours had the same dough base, and different fillings and icings were applied to create unique flavours.

Cream and custard were prepared onsite. Cream fillings were made by whipping heavy cream. Custard fillings were made in batches using sugar, milk, and custard powder, with purchased flavourings added for different donut flavours. Flavourings were stored in tubs and reportedly used until empty, a general duration of approximately two days. Compliance with storage times could not be confirmed, because date labels were missing from some storage containers. The food premises used reusable piping bags for cream and custard fillings, which were cleaned with soap in a sink. Nutella, salted caramel, and jam fillings were purchased and injected into donuts using designated nozzles. Unsold donuts were reportedly disposed of each evening.

The proprietor initially reported only two staff members onsite during the study period; however, this was later revised to two staff in the kitchen and two who served customers. Donuts were reportedly served by staff wearing gloves and using tongs and were kept refrigerated before sale. Gloves were not worn during food preparation and hand washing facilities were available in the kitchen.

The food premises primarily conducted sales through walk-in customers and through fulfilment of pre-booked orders. Orders were taken over the phone; the proprietor reported disposing of order records immediately after fulfilment. An unknown number of orders were also fulfilled through third-party food delivery applications. The proprietor was not able to access order information through third-party food delivery applications, and ACT Health did not pursue these order lists further for active case finding.

The proprietor denied any reports of staff illness during the study period and reported no incidences of vomiting or diarrhoea on site among staff or patrons.

Following the outbreak investigation, staff at the food premises were advised on the transmission routes for gastrointestinal illness and were provided education on proper food handling, cleaning and sanitising techniques.

Laboratory investigation

Food and environmental samples

No targeted pathogens were detected in the six food samples, the seventeen environmental swabs, or the piping bag. Two food samples returned results above detectable limits for coliforms; both samples were fillings made at the premises. The sample of tiramisu custard filling returned a coliform most probable number (MPN) of 4.5 per gram and the cream filling sample returned a coliform MPN of 920 per gram. The cream filling sample also had a SPC of 920,000 colony-forming units (CFU) per gram.

The sample of white chocolate icing recorded a SPC result of 33,000 CFU per gram, which was an unusual result for an icing product. The interview with the proprietor found that

the same scoop had repeatedly been used for the white chocolate buds. The scoops were also stored within the product and may have provided a vehicle for contamination.

Human samples

Of the eleven specimens collected, eight were positive for norovirus. This included two specimens that returned negative norovirus antigen results when initially tested but were PCR-positive when sent to a second laboratory for confirmatory testing.

Two specimens were negative for norovirus, and for all other pathogens screened for in the laboratory tests. One specimen was not tested for norovirus and was negative for all the pathogens included in the laboratory testing.

Discussion

The epidemiological investigation was suggestive of a very large norovirus outbreak associated with donuts from a food premises in the ACT. The symptom profile, incubation period, and illness duration satisfied Lively's criteria for norovirus infection.[6] The epidemiological investigation was supported by eight stool samples positive for norovirus.

This investigation highlights the potential for a foodborne illness outbreak with donuts as a vehicle for infection. Foodborne norovirus outbreaks have historically been associated with foods which do not have a kill step in preparation or which are subject to significant handling, such as salads and sauces.[7–12] Norovirus is a highly contagious pathogen that has the potential to cause large-scale foodborne outbreaks with ready-to-eat foods generally, as only a low dose is required to cause illness; the pathogen does not need to multiply to reach infectious dose levels.[13,14] While two recent norovirus outbreaks have been associated with donuts in the United States of America in grey literature,[15,16] to the best of our knowledge, this is the first Australian foodborne norovirus outbreak associated with donuts. This investigation highlights the potential for a foodborne illness outbreak in a food product not previously considered as a vehicle for norovirus.

While the source of contamination was not confirmed, it is suspected that a food handler worked while infectious and contaminated the donuts. The only statistically significant association with illness found in this study was consumption of any filled donut, the preparation of which involved close handling of each donut after cooking. The elevated coliforms and SPC results in one sample may indicate improper food handling practices, although these results were not consistent across all laboratory-tested samples. Elevated coliforms were present in two filling samples results found through the laboratory investigation. Illness in a food handler has previously been reported as the source of norovirus foodborne outbreaks,[8,9,11,12,17–21] and of foodborne outbreaks associated with bakeries.[22–26] There were no reports of vomiting or diarrhoeal episodes among patrons onsite, making it unlikely that environmental contamination from a patron was the source of infection. The food handlers at the food premises did not provide stool specimens for testing. These factors together suggest that an ill food handler engaging in food preparation was the most likely source of infection. There is the potential for a food handler to have worked with an asymptomatic norovirus infection;[27–29] however, the scale of illness associated with this outbreak suggests there was a lapse in hand hygiene and proper food handling procedures regardless. While national food standards require exclusion from food handling of employees with a gastrointestinal illness,[30] the lack of leave entitlements for casual employees may be a disincentive to remain away from work. This outbreak reinforces the importance of safe food handling practices and of exclusion of ill staff to prevent further spread of illness.

A major limitation of the investigation was the inability to conduct active case finding. The food premises reported that most donuts were purchased by walk-in customers and there were limited records of orders. In addition, no

public health alerts were released regarding the outbreak or an alert indicating an increase of gastroenteritis in the community, and case finding through food delivery applications was not pursued. The true extent of this outbreak remains unknown. Relying on passive case finding biases the epidemiological findings towards ill patrons who may be more motivated to contact public health units and to complete an interview. A lack of responses from well patrons limited our capacity to conduct an analytical study for the whole outbreak. Measurement bias was minimised by using a standard questionnaire based on the menu of the food premises; however, recall of specific flavours from participants may have been limited when several days had passed since the event, when the food premises could not provide accurate records of what donuts were sold on each day, or when the participant was not the person who purchased the donuts. Finally, while stool samples were able to identify the cause of the illness, no food or environmental samples were able to be tested for viral pathogens.

This outbreak investigation was one of the largest foodborne illness outbreaks ever investigated in the ACT. It is essential that food premises and food regulators promote and enforce exclusion of ill food handlers from work to prevent further illness. The rise of third-party food delivery services is an emerging challenge for the pursuit of active case findings, and the role of such delivery services in outbreak investigations should be explored further. Future foodborne illness outbreaks should employ active case finding, where possible, to provide greater certainty in the investigation and its findings.

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