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Fresh produce-associated foodborne disease outbreaks in Australia, 2001 to 2017

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# Abstract

Fresh produce is an important source of foodborne outbreaks in Australia. Using descriptive analysis, we examined confirmed and suspected foodborne outbreaks associated with fresh produce in Australia recorded in the OzFoodNet outbreak register from 2001 to 2017. The outbreak register contains reports of foodborne disease outbreaks collected by OzFoodNet epidemiologists and public health officials. A fresh produce outbreak was defined as the occurrence of two or more cases of the same illness in which the investigation had implicated a common food and this food contained fresh produce. A total of 92 fresh produce outbreaks were reported, encompassing 3,422 reported illnesses, 446 hospitalisations and four deaths. Of these outbreaks, 76.1% (70/92) were caused by a known pathogen, with the majority caused by either *Salmonella enterica* (n = 30) or Norovirus (n = 29). Most outbreaks (77.2%; 71/92) were associated with consumption of foods containing multiple ingredients, some of which were not fresh produce. The largest outbreaks associated with a single fresh produce item included bean sprouts contaminated with *S. enterica* serovar Saintpaul (419 illnesses and 76 hospitalisations) and semi-dried tomatoes contaminated with Hepatitis A (372 illnesses and 169 hospitalisations). Restaurants (45.7%; n = 42/92) and commercial catering (15.2%: n = 14/92) were common settings for fresh produce outbreaks. Outbreaks occurred in all states and territories of Australia and in all seasons, with an increased frequency in the warmer months (September–May). Although the number of fresh produce-associated outbreaks did not seem to be increasing in Australia, integrated surveillance is needed to rapidly identify sources of infection due to the propensity of these outbreaks to be large and widespread.

Keywords: Australia; foodborne disease; fresh produce; Norovirus; outbreaks; Salmonella; sprouts

# Introduction

The increasing variety of fresh produce sold worldwide, together with an industrialised production process, has resulted in a rise in the frequency of produce-linked disease outbreaks.1 Traditionally, foods of animal origin such as eggs, meat, and dairy products have dominated outbreaks of foodborne illness.2 However, with the continual demand for fresh produce, better outbreak surveillance, and improved methods for detecting pathogens, new food vehicles have been associated with outbreaks, such as semi-dried tomatoes,3 fresh garlic,4 peanuts,5 cantaloupe or rockmelon,6 papaya,7 and baby corn.8

Fruit and vegetables can be contaminated with pathogenic microbes at any stage of the production process and this can cause human disease.1 Fresh fruit and vegetables are frequently eaten raw or with minimal processing, and this lack of a pathogen kill step increases the risk of foodborne illness.9 Common bacterial pathogens associated with fresh produce outbreaks include *Escherichia coli*, *Salmonella* spp., and *Listeria monocytogenes*. These can persist in soil, water, or manure, posing a contamination risk.10

In Australia, there are around 4.1 million cases of foodborne gastroenteritis annually, with an estimated financial burden of $AUD 1.2 billion per year.11,12 Along with the socioeconomic cost, outbreaks have been shown to have a lasting effect on the purchasing behaviours of consumers, leading to local and global trade disturbances and associated economic impacts.13 To date there has not been a detailed, nationwide review of Australian outbreaks of foodborne illness due to fresh produce. As outbreak data is critical both economically and in public health, this review aims to define the state of foodborne disease outbreaks that pertain to fresh produce in Australia. The specific objectives of this study are therefore: (i) to summarise the trends among outbreaks associated with fresh produce; (ii) to identify the most frequently reported aetiological agents, food preparation settings and produce types implicated in these outbreaks; and (iii) to describe the geography and seasonality of fresh produce outbreaks, using data reported by OzFoodNet, Australia’s foodborne disease surveillance system, from 2001 to 2017.

# Methods

## Data source

OzFoodNet is the national network for foodborne disease surveillance and response in Australia and has conducted surveillance of enteric and foodborne outbreaks since 2000.14 OzFoodNet epidemiologists across Australia enter data on all foodborne disease outbreaks into a national database. Data were obtained from OzFoodNet’s Outbreak Register to examine foodborne outbreaks associated with fresh produce during the years 2001–2017. A limitation of the dataset is that prior to 2002, outbreaks in the Northern Territory and in areas of New South Wales were not included in the reporting. Outbreak reports recorded as ‘foodborne’ or ‘suspected foodborne’ that included a fresh produce item as the vehicle were extracted from the register. Data collected for each outbreak included the setting of the outbreak, where the food was prepared, the symptom onset date for the first case in the outbreak, the number of symptomatic cases, the number of cases that were confirmed by laboratory analysis, the number of cases hospitalised, the number who died during the outbreak, the median incubation period of cases, the median duration of illness, epidemiological methods (case series, case control study, cohort study, descriptive study, no formal study), evidence (statistical, microbiological, descriptive) and the organism (known or suspected) responsible for the illness. For large outbreaks of foodborne disease, published research articles, publicly available OzFoodNet quarterly and annual reports, and Food Standards Australia New Zealand (FSANZ) reports were used to identify the most accurate total number of cases.

## Inclusion, exclusion, and categorisation criteria

A fresh produce outbreak was defined by the occurrence of two or more cases of a similar illness after consumption of a common food or meal containing uncooked fresh produce. The aetiological agents were the bacteria or viruses identified as causing the foodborne disease as described by the United States Centers for Disease Control and Prevention (CDC).15 The food vehicle field was manually reviewed and outbreaks that did not include fresh produce, where the produce item(s) were cooked, or where the food vehicle was unknown, were excluded from this review. Outbreaks with no statistical, microbiological, or descriptive evidence that implicated the food vehicle were also excluded. Additionally, outbreaks that were deemed unlikely to have been caused by fresh produce items were excluded. These included outbreaks due to *Bacillus cereus* and rotavirus, or if the dish contained egg or chicken and the aetiological agent was *Salmonella* Typhimurium16–18 or *Campylobacter*. In total, 88 outbreaks were excluded from the study.

Outbreaks were categorised by whether the food vehicle contained one or multiple ingredients. Single-ingredient outbreaks were further categorised into i) primary fresh produce: raw agricultural product such as melons or salad leaves; and ii) minimally processed fresh produce: macerated, semi-dried or juiced fresh produce. Multiple-ingredient outbreaks were categorised into iii) mixed dish: the fresh produce item was a component of a mixed dish that may have contained non-fresh-produce ingredients (e.g., meat, dairy, etc.); and iv) salad: a mixture of raw fresh produce items. Seasonality was assigned by the month of the first illness in the outbreak. Microsoft Excel (version 16.54) was used to analyse the data and to generate figures.

# Results

## Summary of outbreaks

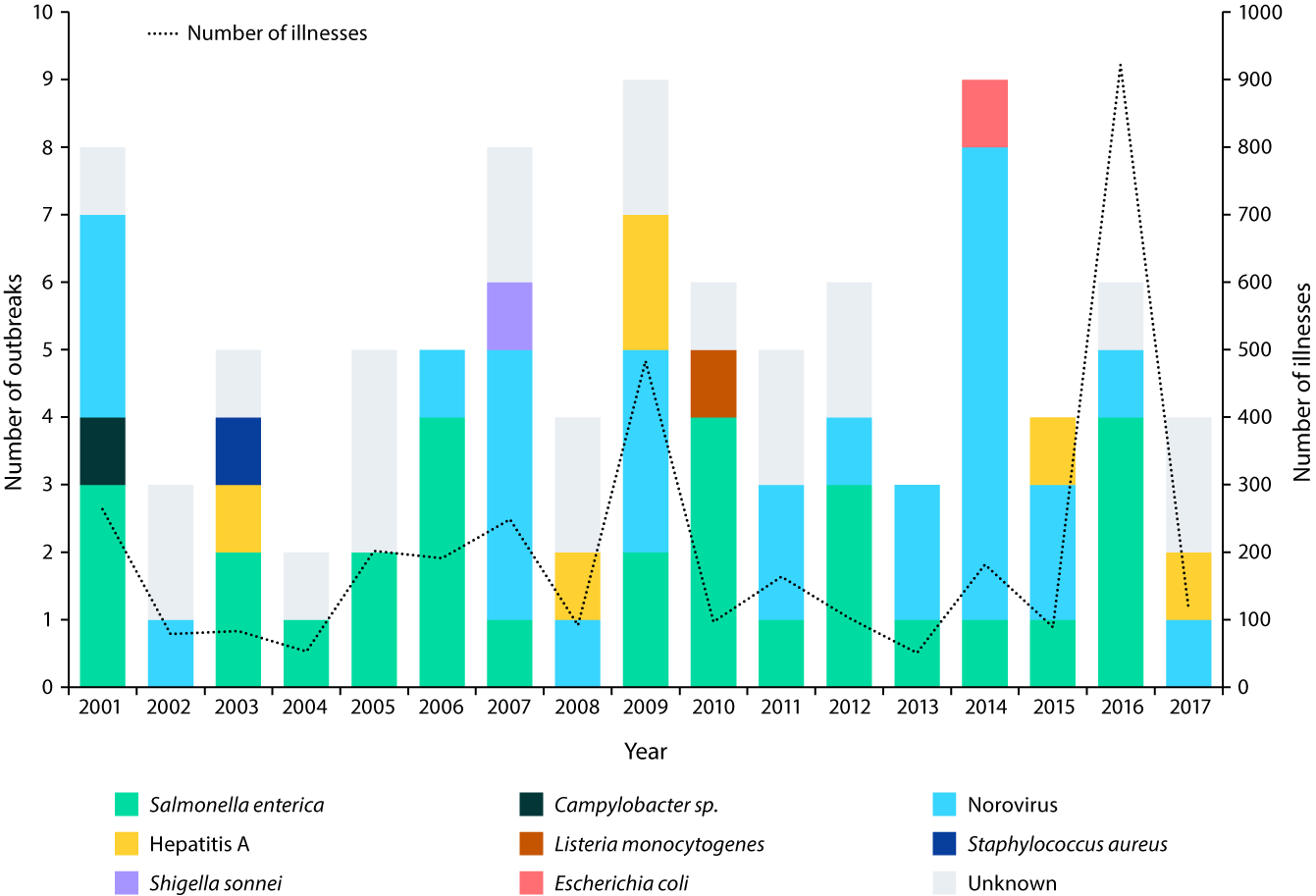
Ninety-two confirmed or suspected foodborne outbreaks associated with fresh produce were reported to OzFoodNet from 2001 to 2017 (Figure 1, Table A.1). These resulted in 3,422 reported illnesses, 446 hospitalisations and four deaths. The deaths occurred in outbreaks that implicated semi-dried tomatoes (2009) or melons (2010 and 2017) as the food vehicle. Within each outbreak, the median age of case-patients ranged from 4 to 78 years old.

Epidemiological investigations were conducted on 95.6% of the fresh produce outbreaks (88/92; Table A.1), with case series (34.8%; 32/92) and cohort studies (41.3%; 38/92) being the most common. Statistical evidence was used to implicate a food vehicle in 58.7% (54/92) and compelling descriptive evidence was used in 37.0% (34/92) of outbreak investigations. Although all outbreaks had some form of evidence, only 33.7% (31/92) had laboratory evidence (Table A.1).

## Aetiological agents associated with outbreaks

An aetiological agent was confirmed in 76.1% (70/92) of the outbreaks. The most frequently implicated agents were *S. enterica* (32.6%; 30/92) and Norovirus (31.5%; 29/92) (Figure 1, Table A.1). Among the thirty *S. enterica* outbreaks, Typhimurium (40%; 12/30) and Saintpaul (13.3%; 4/30) were the most frequent serotypes. There was only one outbreak of *L. monocytogenes* and this led to the highest proportion of hospitalisations of any aetiological agent (88.9%; 8/9) and two fatalities. Hepatitis A infections also led to a high proportion of hospitalisations (38.3%; 195/509) and one fatality. The proportion of *Salmonella* illnesses that led to hospitalisations was 13.3% (220/1652) with one fatality, and Norovirus had the lowest hospitalisation rate at 1.8% (14/760).

Figure 1: Number of outbreaks and illnesses associated with fresh produce, including the aetiological agent associated with each outbreak, Australia, 2001–2017a



a Data source: OzFoodNet.

## Outbreaks linked to single-ingredient primary fresh produce

Single-ingredient fresh produce outbreaks included those attributed to a single primary fresh produce item (e.g., bean sprouts or melons) and those with a single produce item that was minimally processed (e.g., frozen berries or semi-dried tomatoes) (Table 1). Twenty-one of the 92 (22.8%) outbreaks were associated with a single fresh produce ingredient. The largest outbreak was due to bean sprouts contaminated with *Salmonella* Saintpaul in 2016, where 419 illness and 76 hospitalisations were reported. The second largest single-ingredient outbreak was attributed to imported semi-dried tomatoes contaminated with Hepatitis A in 2009, with 372 illness and 169 hospitalisations reported. Among the single-ingredient outbreaks, the most commonly implicated aetiological agent was *S. enterica* (n = 15) followed by Hepatitis A virus (n = 4). Outbreaks where a primary fresh produce item was implicated as the food source resulted in 1,854 reported illnesses and 385 hospitalisations.

## Settings and categories of fresh produce outbreaks

Fourteen different settings were associated with the 92 fresh produce outbreaks (Figure 2). Restaurant (45.7%; 42/92) and commercial catering (15.2%; 14/92) settings had the highest number of outbreaks, and these were frequently due to multiple-ingredient mixed dishes and salads containing fresh produce. Across all fresh produce outbreaks, salad (43.5%; 40/92) and mixed dish (29.3%; 27/92) categories were more commonly implicated than were single-ingredient primary fresh produce (20.7%; 19/92) and minimally processed fresh produce (6.5%; 6/92) (Figure 2A). Primary produce (42.7%; 1462/3422) and salads (26.1%; 894/3422) led to the highest number of illnesses. For these, the settings most implicated were the community (36.2%; 1239/3422) followed by restaurants (23.3%; 798/3422) and imported food (16.4%; 560/3422) (Figure 2B).

## Seasonality of fresh produce outbreaks

Fresh produce outbreaks were more common in the warmer months and became less frequent during the southern hemisphere winter (June–August; Figure 3). Across all outbreaks, *S. enteric*a was the most common aetiological agent (32.6%; 30/92), occurring in all seasons.

## Geographical distribution of outbreaks

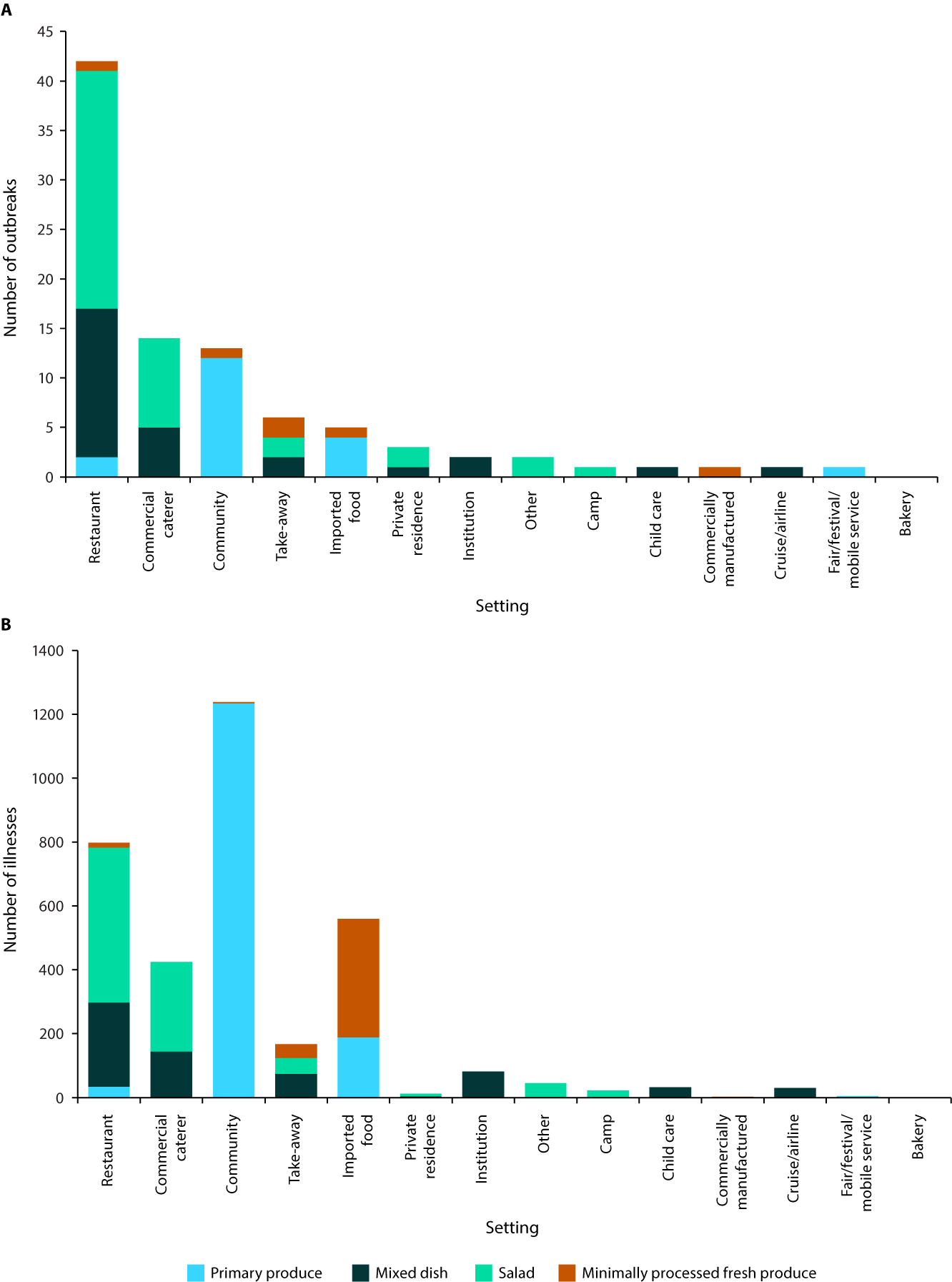
Outbreaks were reported in all eight Australian states and territories (Table A.1), with the largest number of outbreaks occurring in Victoria (22.8%; 21/92), followed by New South Wales (21.7%; 20/92) and Western Australia (18.5%; 17/92). There were eleven multi-state outbreaks (11.9%; 11/92).

Table 1: Fresh produce outbreaks attributed to a single-ingredient fresh produce item reported to OzFoodNet from 2001 to 2017

|  | Food | Jurisdictiona | Year | Organism | Category | Setting | Ill | Hospitalised | Additional references |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | Imported peanuts | MJOI | 2001 | *Salmonella* Stanley and *Salmonella* Newport | Imported primary produce | Community | 32 | 3 | 5; 19-21 |
| 2 | Shredded iceberg lettuce | Qld | 2001 | *Salmonella* Bovismorbificans | Minimally processed fresh produce | National franchised fast food | 36 | 6 | 19; 22 |
| 3 | Cucumber (suspected) | Vic. | 2003 | *Salmonella* Litchfield and *Salmonella* Kinondoni | Primary produce | Community | 6 | 1 | 23 |
| 4 | Alfalfa sprouts | WA | 2005 | *Salmonella* Oranienburg | Primary produce | Community | 126 | 30 | 24; 25 |
| 5 | Alfalfa sprouts | Vic. | 2006 | *Salmonella* Oranienburg | Primary produce | Community | 15 | 2 | 26; 27 |
| 6 | Paw paw/papaya | MJOI | 2006 | *Salmonella* Litchfield | Primary produce | Community | 26 | 5 | 7; 21; 26; 28 |
| 7 | Rockmelon | MJOI | 2006 | *Salmonella* Saintpaul | Primary produce | Community | 115 | 9 | 6; 21; 26; 28 |
| 8 | Imported baby corn | Qld | 2007 | *Shigella sonnei* | Primary produce | Community | 55 | 3 | 8; 21; 29; 30 |
| 9 | Fresh chillies used to prepare chilli sauce | NSW | 2009 | *Salmonella* Chester | Minimally processed fresh produce | Restaurant | 14 | 2 | 31 |
| 10 | Imported semi-dried tomatoes | MJOI | 2009 | Hepatitis A virus | Minimally processed fresh produce | Community | 372 | 169 (1 fatality) | 3; 21; 31 |
| 11 | Frozen berries | WA | 2009 | Hepatitis A virus | Primary produce | Other | 4 | 1 | 31; 32 |
| 12 | Paw paw/papaya | WA | 2009 | *Salmonella* Saintpaul | Primary produce | Community | 17 | 3 | 31 |
| 13 | Melons | MJOI | 2010 | *Listeria monocytogenes* | Primary produce | Community | 9 | 8 (2 fatalities) | 33 |
| 14 | Suspect mango | NT | 2011 | *Salmonella* Saintpaul | Primary produce | Fair/festival/ mobile service | 5 | 0 | 34 |
| 15 | Raw almonds | MJOI | 2012 | *Salmonella* Typhimurium | Primary produce | Community | 43 | 7 | 35 |
| 16 | Imported frozen berries | MJOI | 2015 | Hepatitis A virus | Imported primary produce | Community | 67 | 16 | 36; 37 |
| 17 | Snow pea sprouts | WA | 2015 | *Salmonella* Muenchen | Primary produce | Community | 4 | 2 | 38 |
| 18 | Bagged salad products | MJOI | 2016 | *Salmonella* Anatum | Primary produce | Community | 311 | 24 | 39 |
| 19 | Mung bean sprouts | MJOI | 2016 | *Salmonella* Saintpaul | Primary produce | Community | 419 | 76 | 39 |
| 20 | Rockmelon | MJOI | 2016 | *Salmonella* Hvittingfoss | Primary produce | Community | 144 | 13 (1 fatality) | 39 |
| 21 | Imported frozen berries | MJOI | 2017 | Hepatitis A virus | Imported primary produce | Community | 34 | 5 | 37; 40 |

a ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia; MJOI: multi-jurisdiction outbreak investigation.

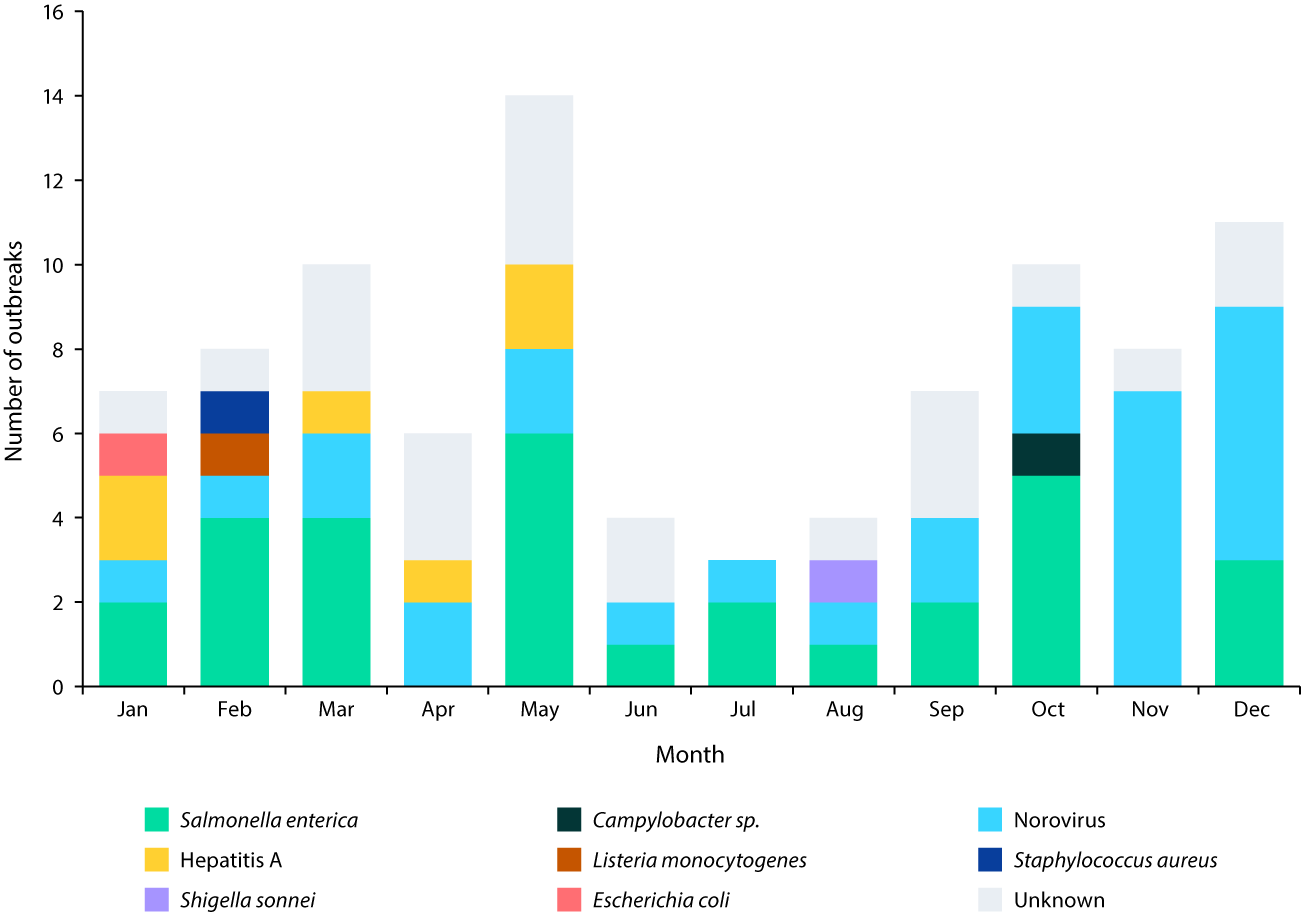
Figure 2: Settings of consumption of foods implicated in fresh produce outbreaks, ordered by (A) the number of outbreaks and (B) the number of illnesses associated with each setting, Australia, 2001–2017a,b



a Source: OzFoodNet.

b Colours indicate the food category implicated in the outbreaks.

Figure 3: Seasonal distribution of outbreaks associated with fresh produce in Australia, 2001–2017a



a Source: OzFoodNet; n = 92.

# Discussion

Fresh-produce-associated outbreaks were an important cause of morbidity and mortality in Australia during 2001–2017. Across the 17-year period analysed, *S. enterica* was the most commonly reported aetiological agent, accounting for 32.6% of the outbreaks. *Salmonella enterica* serotype Saintpaul was a significant cause of fresh-produce-associated illness and was implicated in four outbreaks, resulting in 556 illnesses and 88 hospitalisations, with two widely publicised outbreaks involving rockmelons in 2006 and mung bean sprouts in 2016. Serotype Saintpaul has also been implicated in large outbreaks internationally, including a hot chili pepper outbreak in the United States of America (USA) in 2008 that resulted in 1,500 illnesses.41 In an international study, Li et al. (2018)42 reviewed outbreaks from 2010–2015 and reported that *S. enterica* contributed to 22.9% of fresh-produce-associated outbreaks in the United States, 16% in the European Union, 15.8% in Japan, 3.8% in New Zealand and 15% in Canada. In response to the problems with *Salmonella*, Australia’s ‘Foodborne Illness Reduction Strategy 2018‒2021+’ was introduced with the aim to reduce the incidence of foodborne *Salmonella* infections,43 and by 2021 there was a 20% decrease in all salmonellosis cases compared to previous years.44 Ongoing studies will be required to determine the efficacy of this strategy in reducing *Salmonella* risks specifically relating to fresh produce. The current study highlights the prevalence of *S. enterica* as a contaminant of fresh produce in Australia, as well as the importance of policy responses in mitigating the risks associated with *Salmonella*.

Norovirus was the second most common aetiological agent behind *Salmonella* in this study. Norovirus is a major source of fresh produce outbreaks globally,9 and was the most frequent aetiological agent linked to produce-associated outbreaks in the USA from 1998–201345 and in the European Union from 2004–2012.46 The vast majority of all Norovirus outbreaks in this study (93.5%) were traced to restaurants or commercial catering settings, consistent with its transmission from person to person and from food handlers to food to consumers.47 In Australia, norovirus infections are not required to be reported to public health surveillance, making it difficult to detect norovirus outbreaks.

Hepatitis A was also an important cause of the reported outbreaks. Imported tomatoes contaminated with Hepatitis A virus led to a severe outbreak of foodborne illness in 2009, with 419 illnesses and 169 hospitalisations.3 During the same time period as the current study, Hepatitis A outbreaks due to imported contaminated semi-dried tomatoes were reported in France and the Netherlands.48,49 Hepatitis A virus was also linked to three frozen berry outbreaks in the current study, with the two largest of these involving imported produce. Hepatitis A virus and human norovirus are both temperature-stable viruses that can survive freezing,50 so for minimally processed fresh produce items such as tomatoes and berries, contamination of imported and/or frozen fresh produce with these viruses poses a significant public health risk.37 The current study highlights the varied manifestations of viral outbreaks. Norovirus infections were frequently associated with food settings and meals where food handlers were likely to be an important source of contamination, as norovirus is highly infectious and causes explosive outbreaks of gastroenteritis.51 In contrast, Hepatitis A virus outbreaks were rarer but led to a greater proportion of cases hospitalised, and these were more frequently linked to contaminated single-ingredient primary fresh produce items such as tomatoes and berries imported from countries where hepatitis A infection is endemic.37

Sprouts were the most common single-ingredient primary fresh produce item associated with outbreaks of gastroenteritis. Sprouts are recognised as a significant horticultural cause of foodborne disease outbreaks globally,52 as they are often eaten raw and the warm and moist sprouting conditions promote the growth of bacteria, including pathogens.53 The largest outbreak in the dataset occurred in 2016, when contamination of mung bean sprouts by *Salmonella* Saintpaul led to 419 illness and 76 hospitalisations. Sprouts have been linked to serious outbreaks internationally, with a single *E. coli* O104:H4 outbreak due to consumption of Fenugreek sprouts in 2011 involving 16 countries with more than 4000 illnesses.54 After large sprout outbreaks occurred in Australia in 2005–2006, food standards were implemented to help decrease foodborne illnesses relating to their consumption.55,56 Despite this, sprout-related outbreaks occurred in 2015, 2016 and 2018.39,57–59 In this study, all sprout-related outbreaks involved *S. enterica*, which is an association that has been reported across the world.46,55,60,61

After sprouts, melons were the primary fresh produce item most frequently linked to outbreaks. Melon-associated outbreaks have continued to occur beyond the date range of the dataset, with the consumption of rockmelons contaminated with *L. monocytogenes* resulting in 22 cases and seven fatalities in 2018.62 In response to these outbreaks, production and processing standards aimed at mitigating foodborne illnesses associated with melons were enacted in Australia in 2022.63 Melons are also an important source of foodborne disease outbreaks in the United States, with 28 outbreaks linked to the consumption of melon during 2001–2017.64 The most severe of these outbreaks was caused by the contamination of rockmelons with *L. monocytogenes*, resulting in 147 cases and 33 fatalities.65 Strict adherence to food safety standards is crucial to prevent further instances of foodborne illnesses related to melons.

Analysis of the settings and food categories revealed that there were two main types of foodborne outbreaks associated with fresh produce in this study. First were outbreaks in the community resulting from the contamination of a single-ingredient primary fresh produce item. These were less frequent but led to the highest number of illnesses and fatalities, presumably because primary fresh produce can cause a large number of illnesses due to their widespread distribution, difficulties in traceback identification, and cross-contamination and pathogen growth along the supply chain.66 Second were outbreaks associated with restaurant and commercial caterer settings, where the contaminated food categories were mainly salads and mixed meals. These foods are prepared and served in ways that can facilitate pathogen transmission and cross contamination through worker handling, leading to more frequent but comparatively smaller outbreaks.

Outbreaks linked with *Salmonella* were reported in all seasons, with the highest proportion occurring in the warmest months (December–February). A positive association of temperature with *Salmonella* outbreaks has been reported in Australia,67 Canada,68 South Korea,69 and Europe,70 and may be due to increased growth of the enteric bacteria at higher temperatures as well as to the behavioural patterns of consumers.71–73 In contrast, spring time had the highest number of viral outbreaks (12/36), which is a pattern observed previously.74 Different foodborne pathogens have different mechanisms of growth and transmission pathways that lead to seasonal outbreaks patterns,75 consistent with the findings of the current study.

A limitation of this dataset obtained from OzFoodNet is that the outbreaks reported in the register represent only a proportion of those occurring in the community. The degree of under-representation is unknown and is most likely variable by disease and jurisdiction. In general, passive surveillance systems are likely to be biased toward larger outbreaks, as smaller outbreaks are often undetected, not investigated, or lack sufficient evidence for inclusion in the database. Another limitation is misclassification bias, as all outbreaks were labelled as fresh produce-associated but the source of contamination may have been other foods in the mixed or multiple ingredients food categories. This may have resulted in over-representation of the number of outbreaks classified as ‘fresh-produce-associated’. This dataset highlights the need for improved methods for pathogen detection in foodborne outbreak investigations that can better pinpoint the source of contamination.

We conclude that the consumption of fresh produce in Australia produces a significant but relatively small number of outbreaks of foodborne illness that has remained largely unchanged in terms of size and aetiological agent across the 16 years analysed in this report. Consistent with global patterns, sprouts and melons are significant vehicles of bacterial pathogens and can result in severe illness.

# Ethics

Permission for data access was granted by OzFoodNet and ethics approval was obtained through the Australian National University Human Research Ethics Committee (2018/652).

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# Appendix A

Table A.1: Fresh produce outbreaks of gastroenteritis reported to OzFoodNet from 2001 to 2017

| Food | Jurisdictiona | Monthb | Year | Organism | Category | Setting | Ill | Lab confirmed | Hospitalised | Died | Median age | Evidencec | Epidemiological methods |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Suspected cold chicken salad | Vic. | Feb | 2001 | Unknown | Salad | Restaurant | 5 | 0 | 0 | 0 | 37 | CD | Case series |
| Imported peanuts | MJOI | May | 2001 | *Salmonella enterica* serotype Stanley, *Salmonella enterica* serotype Newport | Primary produce | Imported food | 32 | 32 | 3 | 0 | 7 | CD, S, M | Case series |
| Shredded iceberg lettuce | Qld | May | 2001 | *Salmonella enterica* serotype Bovismorbificans | Minimally processed fresh produce | Take-away | 36 | 36 | 6 | 0 | 22.5 | S, M | Case control study |
| Tomato and cucumber salad | Vic. | Oct | 2001 | *Campylobacter* sp. | Salad | Restaurant | 27 | 9 | 0 | 0 | 40 | S | Cohort study |
| Crannachan dessert (raw berries) | WA | Oct | 2001 | Norovirus | Mixed dish | Restaurant | 56 | 1 | 0 | 0 | 0 | S | Cohort study |
| Mango pudding dessert | SA | Dec | 2001 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Restaurant | 28 | 19 | 0 | 0 | 28 | S, M | Case control study |
| Caesar salad | WA | Dec | 2001 | Norovirus | Salad | Restaurant | 24 | 6 | 0 | 0 | 36 | S | Cohort study |
| Chicken spinach salad | WA | Dec | 2001 | Norovirus | Salad | Restaurant | 56 | 1 | 0 | 0 | 37 | S, M | Cohort study |
| Seafood salad; ravioli; grilled chicken | WA | Feb | 2002 | Norovirus | Salad | Restaurant | 60 | 7 | 2 | 0 | 45 | S | Cohort study |
| Meal of pumpkin soup, roast pork, vegetables, fruit salad and icecream | NSW | Sep | 2002 | Unknown | Mixed dish | Restaurant | 4 | 0 | 0 | 0 | Unknown | CD | No formal study |
| Roast beef, rice noodle salad | NSW | Nov | 2002 | Unknown | Salad | Restaurant | 15 | 0 | 1 | 0 | 62 | S | Cohort study |
| Rice salad | NSW | Feb | 2003 | *Salmonella enterica* serotype Typhimurium | Salad | Restaurant | 11 | 1 | 1 | 0 | 28.3 | M | Case series |
| Pasta salad | Qld | Feb | 2003 | *Staphylococcus aureus* | Salad | Other | 16 | 2 | 0 | 0 | 30.9 | M | No formal study |
| Coleslaw | Tas. | May | 2003 | Hepatitis A | Salad | Camp | 22 | 22 | 2 | 0 | 18 | S | Cohort study |
| Suspected cucumber | Vic. | May | 2003 | *Salmonella enterica* serotype Litchfield | Primary produce | Community | 6 | 6 | 1 | 0 | Unknown | CD, M | Case series |
| Vegetable and chilli dish | Vic. | Oct | 2003 | Unknown | Mixed dish | Restaurant | 28 | 0 | 0 | 0 | 20.5 | S | Cohort study |
| Suspected gourmet rolls including red onion | Vic. | May | 2004 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Commercial caterer | 28 | 14 | 3 | 0 | 34.5 | S, M | Cohort study |
| Suspected buffet meal with cold salad | Qld | Jun | 2004 | Unknown | Mixed dish | Restaurant | 25 | 0 | 0 | 0 | 67 | CD | Cohort study |
| Chicken Caesar salad and chicken burger | NSW | Mar | 2005 | Unknown | Mixed dish | Restaurant | 3 | 0 | 2 | 0 | 26 | CD | No formal study |
| Self serve salad bar | NSW | May | 2005 | Unknown | Mixed dish | Institution | 37 | 0 | 1 | 0 | 20 | CD | Case control study and cohort study |
| Suspected coleslaw | NSW | Aug | 2005 | Unknown | Salad | Restaurant | 3 | 0 | 0 | 0 | Unknown | CD | Case series |
| Suspected to be ready to eat food such as hand cut fruit and sandwiches | NSW | Oct | 2005 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Child care | 33 | 10 | 0 | 0 | 3.6 | S | Cohort study |
| Alfalfa sprouts | WA | Oct | 2005 | *Salmonella enterica* serotype Oranienburg | Primary produce | Community | 126 | 126 | 30 | 0 | 38 | S, M | Case control study |
| Alfalfa sprouts | Vic. | May | 2006 | *Salmonella enterica* serotype Oranienburg | Primary produce | Community | 15 | 0 | 2 | 0 | Unknown | S, M | Case series |
| Sweet potato and fetta cheese salad | SA | Jun | 2006 | *Salmonella enterica* serotype Typhimurium | Salad | Restaurant | 6 | 4 | 0 | 0 | 26 | S | Cohort study |
| Rockmelon | MJOI | Sep | 2006 | *Salmonella enterica* serotype Saintpaul | Primary produce | Community | 115 | 115 | 9 | 0 | 22 | S, M | Case control study |
| Pawpaw | MJOI | Oct | 2006 | *Salmonella enterica* serotype Litchfield | Primary produce | Community | 26 | 26 | 5 | 0 | 22 | S, M | Case control study |
| Green salad | WA | Nov | 2006 | Norovirus | Salad | Other | 29 | 10 | 0 | 0 | 73 | S | Cohort study |
| Hommus and tabouli | NSW | Mar | 2007 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Take-away | 71 | 44 | 10 | 0 | 22 | M | Case series |
| Ham; salad; bread | Qld | Mar | 2007 | Norovirus | Mixed dish | Institution | 45 | 2 | 0 | 0 | 38 | S | Cohort study |
| Penne pasta salad (suspected) | Vic. | Apr | 2007 | Unknown | Salad | Commercial caterer | 25 | 0 | 0 | 0 | 19 | S | Cohort study |
| Fresh fruit juices suspected | NSW | May | 2007 | Unknown | Minimally processed fresh produce | Take-away | 6 | 0 | 0 | 0 | 28 | CD | Case series |
| Imported baby corn | Qld | Aug | 2007 | *Shigella sonnei* | Primary produce | Imported food | 55 | 12 | 3 | 0 | 33 | CD, S, M | Case series |
| Mixed salad | Qld | Aug | 2007 | Norovirus | Salad | Restaurant | 24 | 10 | 0 | 0 | 27.4 | S | Case control study and cohort study |
| Fruit salad | Vic. | Sep | 2007 | Norovirus | Salad | Commercial caterer | 18 | 15 | 1 | 0 | 73.5 | S | Cohort study |
| Suspected salad | Qld | Dec | 2007 | Norovirus | Salad | Private residence | 5 | 2 | 0 | 0 | 37 | CD | Case series |
| Deli meat & salad dish | Qld | Mar | 2008 | Norovirus | Mixed dish | Commercial caterer | 56 | 8 | 0 | 0 | 35.5 | S | Cohort study |
| Fattouch salad | NSW | May | 2008 | Unknown | Salad | Restaurant | 17 | 0 | 0 | 0 | Unknown | S | Cohort study |
| Salads and sandwiches | Vic. | May | 2008 | Hepatitis A | Mixed dish | Restaurant | 10 | 10 | 2 | 0 | 37.5 | CD | Case series |
| Ready to eat foods – salads and garnishes | Vic. | May | 2008 | Unknown | Mixed dish | Restaurant | 9 | 0 | 0 | 0 | 37.5 | CD | Case series |
| Fresh chillies used to prepare chilli sauce | NSW | Jan | 2009 | *Salmonella enterica* serotype Chester | Minimally processed fresh produce | Restaurant | 14 | 7 | 2 | 0 | Unknown | CD, M | Case series |
| Semi-dried tomatoes | MJOI | Mar | 2009 | Hepatitis A | Minimally processed fresh produce | Imported food | 372 | 300 | 169 | 1 | 38 | CD, S, M | Case control study |
| Lasagne, chicken Caesar salad | NSW | Apr | 2009 | Unknown | Mixed dish | Restaurant | 5 | 0 | 0 | 0 | Unknown | CD | Case control study |
| Frozen berries | WA | Apr | 2009 | Hepatitis A | Minimally processed fresh produce | Community | 4 | 4 | 1 | 0 | 30 | CD, M | Case series |
| Pawpaw | WA | Aug | 2009 | *Salmonella enterica* serotype Saintpaul | Primary produce | Community | 17 | 17 | 3 | 0 | 18 | M | Case series |
| A salad meal or a meal containing salad | NSW | Sep | 2009 | Unknown | Salad | Restaurant | 13 | 3 | 0 | 0 | 46 | CD | Cohort study |
| Chicken Caesar salad; roast chicken | Qld | Oct | 2009 | Norovirus | Mixed dish | Restaurant | 23 | 6 | 0 | 0 | 39 | S | Cohort study |
| Berry cheesecake | SA | Nov | 2009 | Norovirus | Mixed dish | Restaurant | 21 | 5 | 0 | 0 | 65 | S | Cohort study |
| Green salad | Tas. | Nov | 2009 | Norovirus | Salad | Commercial caterer | 14 | 1 | 0 | 0 | 48.5 | CD, S | Cohort study |
| Melons | MJOI | Feb | 2010 | Listeria monocytogenes | Primary produce | Community | 9 | 9 | 8 | 2 | 78 | CD, S, M | Case series and case control study |
| Pasta salad | Vic. | Feb | 2010 | *Salmonella enterica* serotype Typhimurium | Salad | Commercial caterer | 15 | 6 | 1 | 0 | 12.5 | M | Cohort study |
| Orange and mango fruit drink | NSW | Mar | 2010 | Unknown | Minimally processed fresh produce | Commercially manufactured | 3 | 0 | 0 | 0 | 20 | CD | Case series |
| Suspected peanut/cashew mixture | NSW | Mar | 2010 | *Salmonella enterica* serotype Typhimurium | Primary produce | Restaurant | 19 | 9 | 0 | 0 | 38 | CD | Case series |
| Assorted salads | ACT | Oct | 2010 | *Salmonella enterica* serotype Typhimurium | Salad | Take-away | 47 | 41 | 5 | 0 | 29 | M | Case series |
| Banana milkshake | Qld | Dec | 2010 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Private residence | 4 | 4 | 2 | 0 | 6 | CD | Case series |
| Fruit | Vic. | Jun | 2011 | Norovirus | Primary produce | Restaurant | 15 | 5 | 0 | 0 | 39 | S | Cohort study |
| Salad | WA | Jul | 2011 | Norovirus | Salad | Restaurant | 53 | 1 | 0 | 0 | 28 | CD | Case control study |
| Salad of poached prawns with Thai herbs | NSW | Sep | 2011 | Unknown | Salad | Commercial caterer | 87 | 0 | 0 | 0 | 15.2 | S | Cohort study |
| Suspect mango | NT | Sep | 2011 | *Salmonella enterica* serotype Saintpaul | Primary produce | Fair/festival/mobile service | 5 | 3 | 0 | 0 | 5 | CD | Case series |
| Moroccan chicken salad | Vic. | Dec | 2011 | Unknown | Salad | Restaurant | 4 | 1 | 1 | 0 | 19 | S | Cohort study |
| Prawn salad rolls | Qld | Jan | 2012 | *Salmonella enterica* serotype Infantis | Mixed dish | Restaurant | 2 | 2 | 2 | 0 | 62 | M | Case series |
| Grapes and caramel slice | WA | Jan | 2012 | Unknown | Mixed dish | Commercial caterer | 21 | 0 | 0 | 0 | 46 | S | Case control study |
| Multiple salads | WA | Feb | 2012 | *Salmonella enterica* serotype Anatum | Salad | Take-away | 4 | 4 | 0 | 0 | 39 | M | Case series |
| Lamb salad | NSW | Mar | 2012 | Unknown | Salad | Commercial caterer | 16 | 0 | 1 | 0 | 44 | S | Cohort study |
| Raw almonds | MJOI | Jul | 2012 | *Salmonella enterica* serotype Typhimurium | Primary produce | Community | 43 | 43 | 7 | 0 | 33 | M | Case series |
| Salads | Vic. | Oct | 2012 | Norovirus | Salad | Restaurant | 17 | 2 | 1 | 0 | 36 | CD | Case series |
| Salad | Vic. | Jan | 2013 | Norovirus | Salad | Restaurant | 7 | 4 | 0 | 0 | 54 | CD | Case series |
| Suspect salad | Tas. | Dec | 2013 | *Salmonella enterica* serotype Mississippi | Salad | Restaurant | 36 | 11 | 3 | 0 | 51 | S | Cohort study |
| Salad | WA | Dec | 2013 | Norovirus | Salad | Restaurant | 8 | 3 | 0 | 0 | Unknown | CD | Case series |
| Tabouli or parsley | ACT | Jan | 2014 | *Escherichia coli* | Mixed dish | Take-away | 3 | 0 | 0 | 0 | 26 | M | Case series |
| Garden salad | NSW | May | 2014 | Norovirus | Salad | Restaurant | 6 | 1 | 0 | 0 | Unknown | CD | Case series |
| Grain salad | Vic. | May | 2014 | Norovirus | Salad | Restaurant | 46 | 15 | 0 | 0 | 33 | S | Cohort study |
| Lamb shanks or salad | WA | May | 2014 | *Salmonella enterica* serotype Typhimurium | Mixed dish | Restaurant | 5 | 2 | 4 | 0 | 28 | S | Case control study |
| Suspect fruit salad | Tas. | Nov | 2014 | Norovirus | Salad | Restaurant | 9 | 2 | 1 | 0 | 73 | S | Cohort study |
| Lamb, lettuce and tomato | Vic. | Nov | 2014 | Norovirus | Mixed dish | Commercial caterer | 19 | 4 | 2 | 0 | 21 | S | Cohort study |
| Brownies or cut fresh fruit | Vic. | Nov | 2014 | Norovirus | Mixed dish | Commercial caterer | 20 | 3 | 2 | 0 | 52 | S | Cohort study |
| Thai beef salad | Vic. | Nov | 2014 | Norovirus | Salad | Commercial caterer | 53 | 3 | 1 | 0 | 46 | S | Case control study |
| Leafy salad (green salad or prawn salad) | WA | Dec | 2014 | Norovirus | Salad | Restaurant | 21 | 1 | 0 | 0 | 51 | S | Cohort study |
| Imported frozen berries | MJOI | Jan | 2015 | Hepatitis A | Primary produce | Imported food | 67 | 35 | 16 | 0 | 32 | S, M | Case control study |
| Salad – young leaves with house dressing | Vic. | Sep | 2015 | Norovirus | Salad | Restaurant | 9 | 2 | 0 | 0 | 52 | S | Case control study |
| Snow pea sprouts | WA | Oct | 2015 | *Salmonella enterica* serotype Muenchen | Primary produce | Community | 4 | 4 | 2 | 0 | 62 | CD, M | Case series |
| Multiple salads | WA | Dec | 2015 | Norovirus | Salad | Restaurant | 9 | 1 | 0 | 0 | 66 | CD, S | Cohort study |
| Bagged salad products | MJOI | Feb | 2016 | *Salmonella enterica* serotype Anatum | Primary produce | Community | 311 | 311 | 24 | 0 | 45 | CD, M | Case control study |
| Mung bean sprouts | MJOI | Mar | 2016 | *Salmonella enterica* serotype Saintpaul | Primary produce | Community | 419 | 124 | 76 | 0 | 34 | CD, S, M | Case series and case control study |
| Banana smoothie; berry smoothie; and fish | WA | Mar | 2016 | *Salmonella enterica* serotype Enteritidis | Mixed dish | Cruise/airline | 30 | 13 | 10 | 0 | 62 | S | Case control study |
| Side salad served with meals | Tas. | Apr | 2016 | Unknown | Mixed dish | Restaurant | 13 | 0 | 0 | 0 | 68 | S | Case control study |
| Rocket salad | Vic. | Apr | 2016 | Norovirus | Salad | Commercial caterer | 5 | 1 | 0 | 0 | 42 | S | Case control study |
| Rockmelon | MJOI | Jul | 2016 | *Salmonella enterica* serotype Hvittingfoss | Primary produce | Community | 144 | 144 | 13 | 1 | 6 | S, M | Case control study |
| Imported frozen mixed berries | MJOI | Jan | 2017 | Hepatitis A | Primary produce | Imported food | 34 | 10 | 5 | 0 | 30 | M | Case series |
| Suspect hummus and vegetable dish | Tas. | Apr | 2017 | Norovirus | Mixed dish | Restaurant | 32 | 4 | 2 | 0 | 39.5 | S | Case control study and cohort study |
| Salads | NSW | Jun | 2017 | Unknown | Salad | Commercial caterer | 48 | 0 | 0 | 0 | Unknown | S | Cohort study |
| Tuna with salad | NSW | Dec | 2017 | Unknown | Salad | Private residence | 4 | 0 | 0 | 0 | Unknown | CD | No formal study |

a ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia; MJOI: multi-jurisdiction outbreak investigation.

b Month in which outbreak started.

c CD: compelling descriptive evidence; S: statistical evidence; M: microbiological evidence.

About Communicable Diseases Intelligence

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