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Monitoring the incidence and causes of disease potentially transmitted by food in Australia: Annual report of the OzFoodNet network, 2018

The OzFoodNet Working Group

Australian Government
Department of Health, Disability and Ageing

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Communicable Diseases Intelligence

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Contents

List of figures

List of tables

Abstract

In 2018, state and territory health departments in Australia received 51,174 notifications of enteric diseases potentially related to food. This was 28% higher than the five-year average number of notifications for enteric diseases in Australia. Consistent with previous years, most notified infections were either campylobacteriosis (n = 33,143; 65%) or salmonellosis (n = 14,144; 28%). In total, 137 gastrointestinal outbreaks, including 127 foodborne outbreaks, were reported in 2018. The remaining ten outbreaks were due to environmental or probable environmental transmission (nine outbreaks) and waterborne or probable waterborne transmission (one outbreak). Foodborne outbreaks affected 1,644 people, resulting in at least 283 hospital admissions and thirteen deaths. Eggs continue to be a source of *Salmonella* Typhimurium infection across the country, with 26 egg-related outbreaks, affecting at least 535 people, reported across five jurisdictions in 2018.

Introduction

The burden of foodborne disease in Australia is significant, with an estimated 4.1 million people infected in Australia each year, costing an estimated $1.2 billion per year.[1]

The OzFoodNet network was established in 2000 by the Australian Government Department of Health, Disability and Ageing to apply concentrated effort at a national level to investigate and understand foodborne disease; to describe more effectively its epidemiology; and to identify ways to minimise foodborne illness in Australia. The OzFoodNet network includes foodborne disease epidemiologists from each state and territory health department, and collaborators from the Australian Government Department of Agriculture, Fisheries and Forestry (Agriculture), Food Standards Australia New Zealand (FSANZ), and the Public Health Laboratory Network (PHLN). OzFoodNet is represented on the Communicable Diseases Network Australia (CDNA), which is Australia's peak body for communicable disease control.

The primary data sources used by OzFoodNet epidemiologists to understand the extent of foodborne disease in Australia include notifiable enteric disease data and reports of gastrointestinal disease outbreaks. This report provides an overview of the national enteric disease surveillance data from 1 January 2018 to 31 December 2018 and the findings from the investigations into gastrointestinal illness outbreaks caused by foodborne, animal-to-person, environmental or waterborne disease that were initiated in Australia between 1 January 2018 and 31 December 2018.

Methods

Population under surveillance

In 2018, the OzFoodNet network covered all Australian states and territories, with an estimated population of 24,992,747 persons as at 30 June 2018.[2]

Data sources

Notified infections

All Australian states and territories have public health legislation requiring doctors and pathology laboratories to notify cases of infectious diseases that are important to public health. State and territory health departments record details of notified cases on surveillance databases. Under the auspices of the *National Health Security Act 2007*, surveillance data is aggregated into a national database known as the National Notifiable Diseases Surveillance System (NNDSS).[i] Notifiable enteric diseases include botulism, campylobacteriosis, cholera, haemolytic uraemic syndrome (HUS), hepatitis A, hepatitis E, listeriosis, paratyphoid fever, salmonellosis, Shiga toxin-producing *Escherichia coli* (STEC) infection, shigellosis and typhoid fever.

Data for this report were extracted from NNDSS in July 2022 and analysed by calendar year using the date of diagnosis. Date of diagnosis was derived for each case from the earliest date supplied by the jurisdiction, which could be the date of onset of the case's illness, the date a specimen was collected, or the date a health department received the notification. Notifications for 2018 include those with a diagnosis date from 1 January 2018 to 31 December 2018. Australian Bureau of Statistics (ABS) estimated resident populations for each state or territory as at 30 June 2018 were used to calculate rates of notified infections.[2] Due to the dynamic nature of NNDSS data, the data presented in this report are subject to change over time.

Change in laboratory methods

Changes in diagnostic laboratory testing procedures, including the increasing uptake of culture independent diagnostic testing (CIDT) using polymerase chain reaction (PCR) and introduction of multiplex PCR (which can detect multiple enteric pathogens on one test), are suspected to have resulted in an increase in notifications for a number of bacterial enteric diseases including campylobacteriosis, salmonellosis, shigellosis and STEC since 2014 (see the OzFoodNet 2016 annual report for more information).[3] CIDT has been introduced at varying times depending on the individual laboratory. The extent to which this has increased notifications of each of these conditions remains unclear.

Enhanced national surveillance for listeriosis

In 2010 OzFoodNet commenced enhanced surveillance data collection on all notified cases of listeriosis in Australia, using a centralised database known as the National Enhanced Listeriosis Surveillance System (NELSS). The primary aim of NELSS is to detect clusters of infection to enable a timely public health investigation and response. In accordance with the Listeriosis National Guideline for Public Health Units,[ii] jurisdictional public health staff conduct case interviews at the time of diagnosis using a standardised questionnaire. Interview data (including food histories), along with information regarding the characterisation of *Listeria monocytogenes* isolates by molecular subtyping methods, are entered into NELSS by OzFoodNet epidemiologists using an open-source secure web-based reporting system known as NetEpi. Commencing in 2016, whole genome sequencing with fortnightly national phylogenetic analysis was conducted for all human *L. monocytogenes* isolates to identify potential clusters for investigation (data not included).

i For further information see https://www.health.gov.au/our-work/nndss.

ii CDNA national guidelines for public health units. Listeriosis: https://www.health.gov.au/resources/publications/listeriosis-cdna-national-guidelines-for-public-health-units.

Enhanced national surveillance for hepatitis A

In July 2017, CDNA endorsed the commencement of a hepatitis A enhanced surveillance data collection pilot study, which involved sequencing strains from all notified cases of hepatitis A nationally (see the 2017 OzFoodNet annual report for more information).[4] Enhanced surveillance commenced on 1 July 2017, with the objectives:

- to better understand hepatitis A molecular epidemiology in Australia through the conduct of national enhanced surveillance through genotyping and sequencing RNA from each case and recording specific risk factor information in a centralised database;
- to understand the risk factors and molecular epidemiology of hepatitis A in Australia; and
- to detect clusters of locally acquired hepatitis A to enable rapid public health action.

Enhanced surveillance of hepatitis A does not impact on jurisdictional public health surveillance practices: all confirmed cases of hepatitis A are followed up as per current jurisdictional surveillance practice and the nationally agreed questionnaire, developed by OzFoodNet and the Hepatitis A Series of National Guidelines Working Group, is used when interviewing cases. De-identified case information is entered onto a secure SharePoint database as cases are notified to jurisdictions, and selected epidemiological and laboratory typing fields are completed by jurisdictional and laboratory staff. This information is interrogated as necessary.

Outbreaks of gastrointestinal disease including foodborne disease outbreaks

Gastrointestinal disease outbreaks may be notified to jurisdictional health departments from a range of sources including doctors, local councils, and members of the public, or identified by OzFoodNet epidemiologists through review of notifiable disease data.

In 2016, OzFoodNet epidemiologists revised the terminology regarding the various modes of transmission of gastrointestinal disease outbreaks. Suspected foodborne, animal-to-person, and waterborne outbreak categories were redefined as probable outbreaks to more accurately reflect the level of evidence available to implicate a mode of transmission. For data analysis and reporting pre and post 2016, suspected and probable categories can be treated as equivalent. In addition, an environmental outbreak category was introduced, to differentiate waterborne outbreaks associated with drinking water from incidental exposure to contaminated water sources in the environment. Waterborne outbreaks from 2013 to 2015 have been redefined using the 2016 case definitions to enable accurate historical comparisons in this report. Refer to Appendix A for the definitions applied to reported gastrointestinal disease outbreaks from 2016 onwards.

Commencing in the 2013–2015 OzFoodNet annual report,[5] person-to-person outbreaks and outbreaks of unknown transmission mode have been excluded from the OzFoodNet annual reports. These modes of transmission have historically accounted for the majority of outbreaks each year. This is a change in practice from previous annual reports and therefore the total number of outbreaks in this report cannot be directly compared with annual reports prior to 2013.

From 2018 onwards, point source outbreaks occurring within multi-jurisdictional outbreak investigations and large community outbreaks have been reported by OzFoodNet and included in annual reports, to improve understanding of the burden and variety of causes of point source outbreaks investigated by OzFoodNet that are connected to larger outbreaks.

Surveillance and outbreak data limitations

Enteric disease surveillance data reported to health departments represent only a proportion of disease in the community as these data rely on people seeking medical attention and undergoing appropriate laboratory testing to confirm a diagnosis. Research in Australia has estimated that only one in five people experiencing gastroenteritis seek medical attention, and are therefore notified.[6] Studies have shown that for every salmonellosis case notified to a health department in Australia there are an estimated seven salmonellosis infections in the community; for every notified STEC case there are an estimated eight STEC infections; and for every notified campylobacteriosis case there are an estimated ten campylobacteriosis infections in the community.[7,8]

The outbreak data within this report have limitations, including the potential for variation in the categorisation of features of outbreaks, depending on differing circumstances and investigator interpretation. Outbreaks are investigated by jurisdictional health departments, where resources and follow-up practices may vary from jurisdiction to jurisdiction. In addition, outbreaks of gastroenteritis are often not reported to health authorities, resulting in under-representation of the true burden of enteric disease outbreaks within Australia. Changes in the number of outbreaks over time should be interpreted with caution. The numbers of cases and outbreaks may differ from summaries previously published, as these may take time to finalise. Outbreaks presented in this report are included based on the investigation commencing in 2018.

Data analysis

All analyses were conducted using R version 4.0 and Microsoft Excel.

Results

Notified infections

In total, 51,174 enteric diseases notifications were reported in 2018 (Table 1).

Table 1: Enteric disease notifications in Australia, 2018

Diseases	Number of notifications 2018	Proportion of all enteric notifications 2018	Mean notifications 2013–2017	% change	2018 rate per 100,000 population
Campylobacteriosis	33,143	65%	22,021	51%	133
Salmonellosis	14,144	28%	16,024	-12%	57
Shigellosis	2,508	5%	1,154	117%	10
Shiga toxin-producing *Escherichia coli* (STEC) infection	562	1%	254	121%	2.2
Hepatitis A	434	1%	193	125%	1.7
Typhoid fever	176	< 1%	126	40%	0.7
Paratyphoid fever	81	< 1%	73	10%	0.3
Listeriosis	74	< 1%	76	-3%	0.3
Hepatitis E	39	< 1%	45	-13%	0.2
Haemolytic uraemic syndrome (HUS)	13	< 1%	17	-23%	0.1
Botulism	0	< 1%	3	-100%	< 0.01
Cholera	0	< 1%	2	-100%	< 0.01
Total	**51,174**	**100%**	**39,989**	**28%**	**–**

Data from the NNDSS, including number of notifications and rate by month, jurisdiction, age group and sex, can be accessed on the National Notifiable Diseases Surveillance System (NNDSS) data visualisation tool.[iii] A summary of each notifiable enteric condition is provided in this report.

iii https://www.health.gov.au/resources/apps-and-tools/national-notifiable-diseases-surveillance-system-nndss-data-visualisation-tool.

Botulism

Botulism is a rare but serious illness that results in paralysis caused by nerve toxins made by *Clostridium botulinum* bacteria. Botulism can result from eating food containing pre-formed botulinum toxin (foodborne botulism); from ingesting food, dust, or soil that contains the bacteria that produce the toxin (intestinal botulism); or from contamination of a wound with the bacteria (wound botulism). Intestinal botulism usually only affects children under 12 months of age and is more commonly known as infant botulism. This is the most common form of botulism in Australia. Foodborne botulism may be found in improperly processed, canned, low acid, or alkaline foods where anaerobic conditions have occurred at some stage.

Surveillance data includes confirmed cases only. A confirmed case requires laboratory definitive and clinical evidence of infection.[iv] All notified cases are followed up by jurisdictional public health staff.

Overall trend

Notifications of botulism are extremely rare in Australia, with a total of 26 cases recorded in Australia since collation of national notification data began in 1992 (Figure 1).[v]

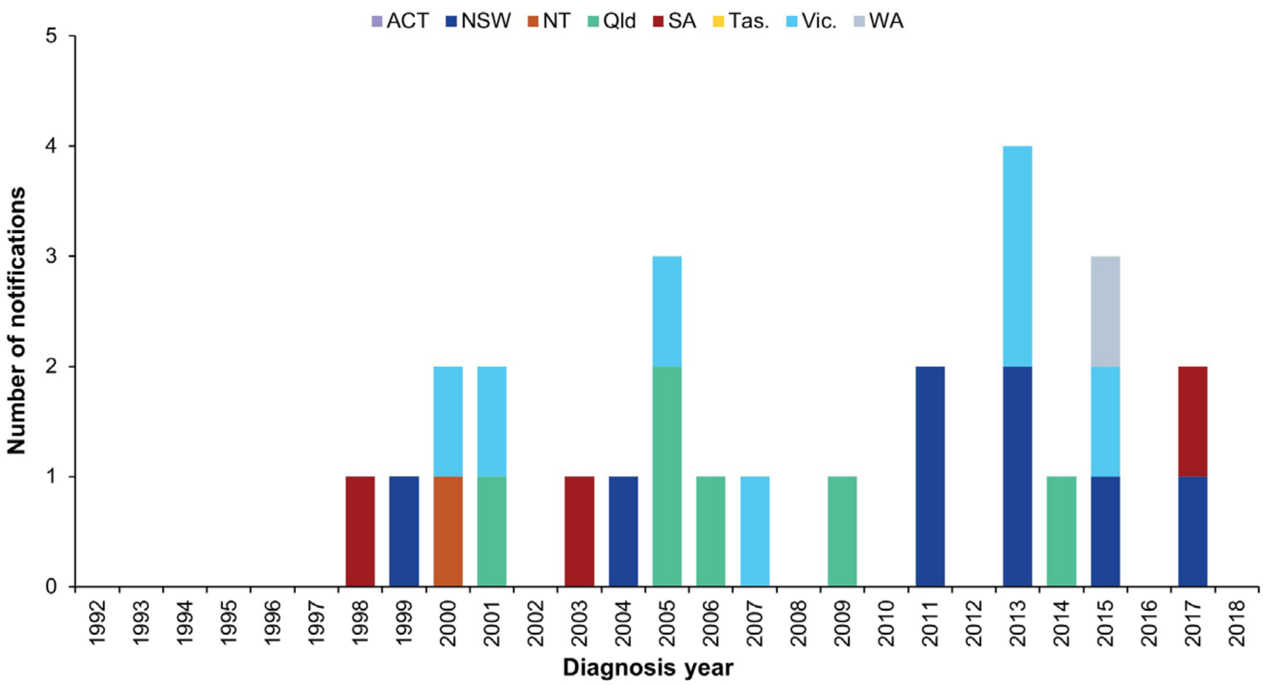
Previous cases in Australia

- Three foodborne botulism cases have been reported to date, including a single case in New South Wales in 1999 where the food source was not identified; a case in Victoria in 2007 associated with consumption of a commercially manufactured convenience food; and a second case in Victoria in 2015 where the suspected source was home cured ham.
- One case of intestinal botulism was reported in a child in 2006.
- The remaining cases have been infant botulism.

Epidemiology of botulism in Australia, 2018

There were no notifications of botulism reported in 2018. The five-year average of botulism notifications was two cases per year between 2013 and 2017.

Figure 1: Botulism notifications in Australia by jurisdiction of residence, 1992–2018



iv Botulism case definition: https://www.health.gov.au/resources/publications/botulism-surveillance-case-definition.

v Botulism became notifiable in all jurisdictions of Australia in 2001.

Campylobacteriosis

Campylobacteriosis is a gastrointestinal disease caused by the *Campylobacter* bacterium. It is a common cause of bacterial gastroenteritis globally, with infection rates in Australia among the highest in the industrialised world.[9] In Australia, it is commonly associated with the consumption of undercooked poultry.[10] Campylobacteriosis may also be acquired through consumption of cross-contaminated foods, animal to person transmission, consumption of unpasteurised milk, and contaminated water.[9]

Surveillance data includes confirmed cases only from all jurisdictions, noting that New South Wales commenced receiving notifications in April 2017. A confirmed case requires laboratory definitive evidence of infection.[vi] Due to the volume of notifications, individual case follow-up is not undertaken routinely in all jurisdictions. Public health follow-up is usually limited to outbreaks and clusters of notified cases.

Overall trend

- The incidence of campylobacteriosis in Australia has increased steadily since 1991, when notification began, to 2011 (Figure 2). A decreasing trend was observed in 2012 and 2013. This may be related to work undertaken with poultry processors to identify and control contamination on-farm and within processing operations in several jurisdictions.[11]
- From 2014, the marked increase in notifications occurring throughout Australia is at least in part due to the increase in PCR testing as a method of laboratory diagnosis. From 2017 onwards, the increase in the number of notifications nationally is also attributable in part to the addition of notifications from New South Wales from April 2017.
- The annual notification rate has decreased from a peak of 147 cases per 100,000 population in 2016 to 133 cases per 100,000 population in 2018.
- There has been a decrease of notifications from most jurisdictions between 2017 and 2018, with the exception of New South Wales.

Previous outbreaks in Australia

- Foodborne outbreaks have been reported each year in Australia. There have been 34 outbreaks of campylobacteriosis reported between 2013 and 2017, with an average of 16 cases per outbreak.
- These outbreaks are commonly associated with consumption of poultry, particularly chicken and duck liver pâté. Reported campylobacteriosis outbreaks account for a small proportion of cases compared with the overall number of cases reported annually. Further information on campylobacteriosis outbreaks is provided in the *Outbreak* section of this report.

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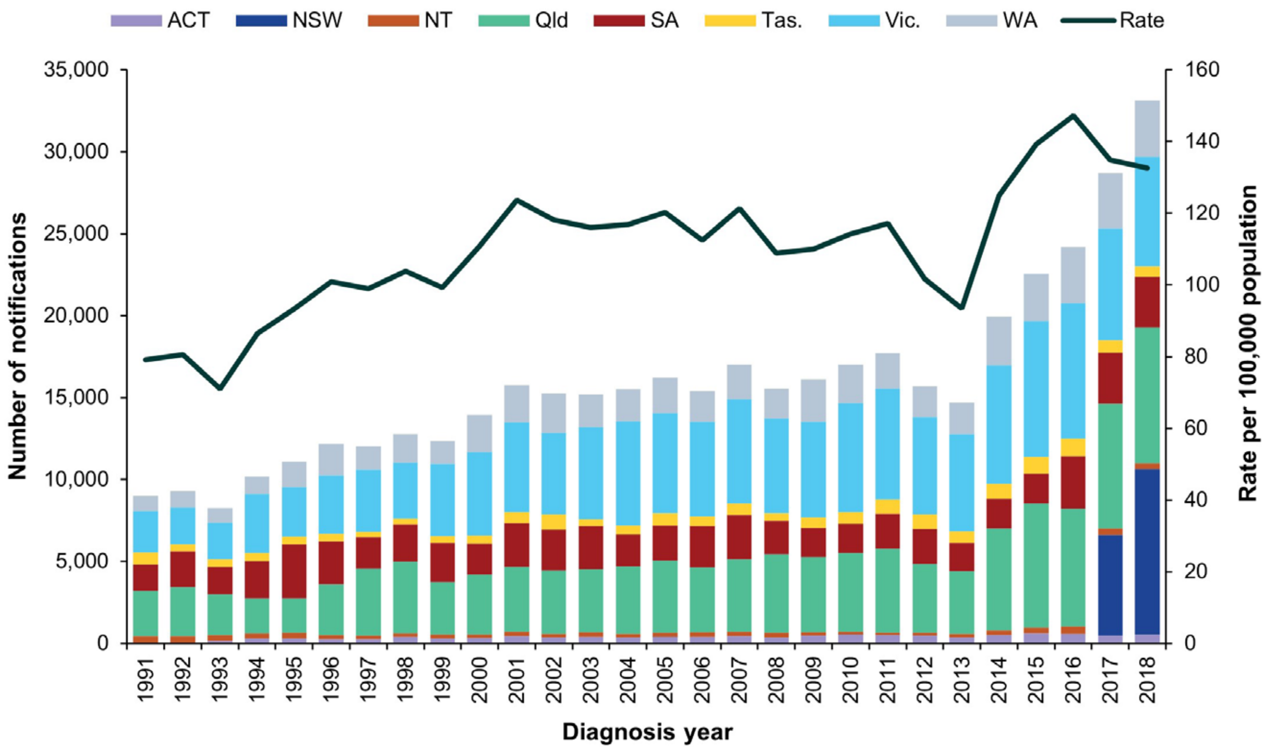
vi Campylobacteriosis case definition: https://www.health.gov.au/resources/publications/campylobacteriosis-surveillance-case-definition.

Figure 2: Campylobacteriosis notifications[a] and rate per 100,000 population[b] in Australia by jurisdiction of residence, 1991–2018



a Campylobacteriosis became notifiable in New South Wales in April 2017.

b Notifications in New South Wales have been excluded from the rate calculation prior to 2018 to avoid comparisons of incomplete data. The rate for Australia between 1991 and 2017 has been calculated using the Australian Bureau of Statistics estimated resident population data for Australia minus New South Wales.

Table 2: Summary of campylobacteriosis notifications in Australia, 2018

Category	Value
Number of notifications	33,143
Rate per 100,000 population	133 cases
Jurisdiction with the highest number of notifications	New South Wales (n = 10,113; 31%)
Seasonality	More common in warmer months, with 20% of all notifications occurring in January and December (n = 6,508)
Foodborne outbreaks	Four
Foods implicated in outbreaks[a]	Lamb kebab (1), pork belly (1), unpasteurised cream (1) and unknown (1)

a Refer to *Foodborne outbreaks* section.

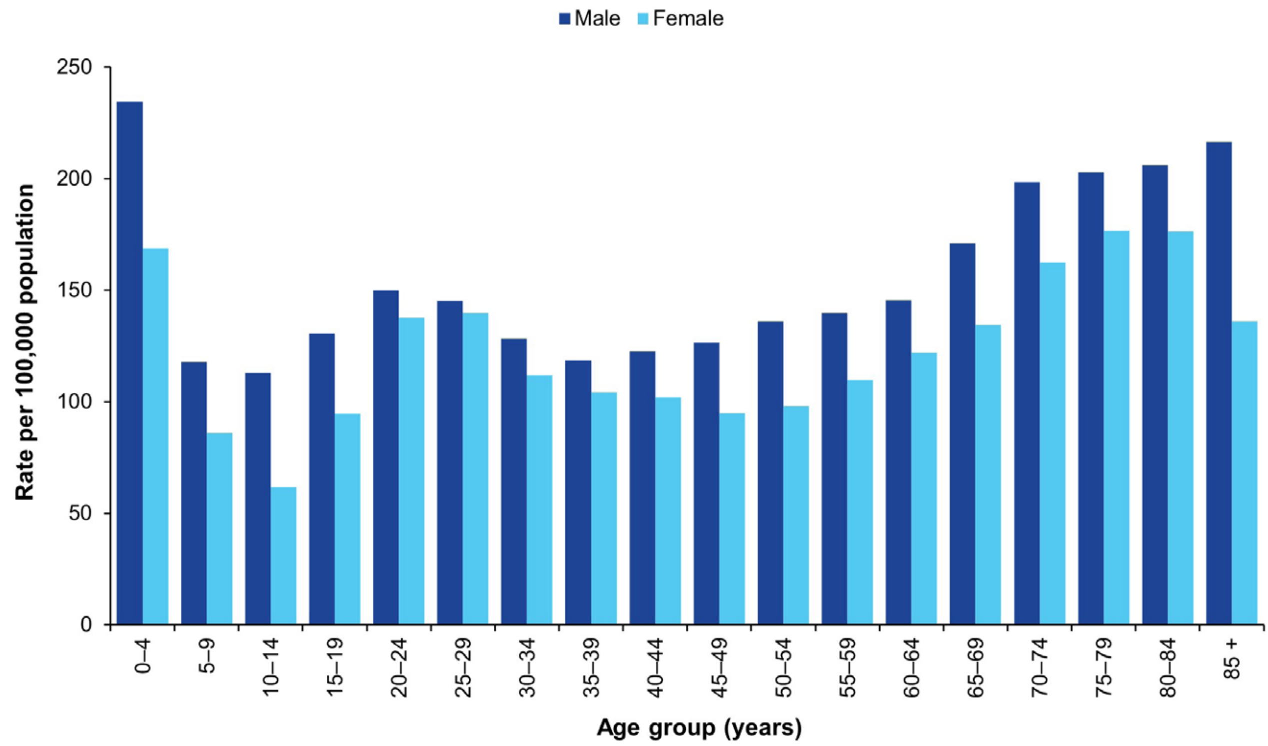
Table 3: Demographics of cases with the highest campylobacteriosis notification rates in Australia, 2018

Category	Group most affected	Rate per 100,000 population	Number (% of all cases)
Age group (years)	0–4	203	3,210 (10%)
Sex	Males	147	18,224 (55%)
Jurisdiction	South Australia	178	3,092 (9%)

Epidemiology of campylobacteriosis in Australia, 2018

- Campylobacteriosis was the most notified enteric pathogen in 2018 (Table 1) across all jurisdictions.
- The highest number of notifications in 2018 occurred in New South Wales.
- The highest rates of infection occurred in children aged 0–4 years, with 203 cases of campylobacteriosis occurring per 100,000 population and those between 80 and 85 years of age (with a rate of 190 cases per 100,000 population). This is consistent with previous years.[5]
- A higher incidence was observed amongst males in every age group when compared with females (Figure 3). The highest male to female ratio was observed among the 10–14 age group with the overall male to female ratio of cases 1.8:1.

Figure 3: Campylobacteriosis notification rate per 100,000 population in Australia by age group and sex, 2018



Cholera

Cholera is an infection of the digestive tract caused by certain toxin-producing strains of the bacterium *Vibrio cholerae*. It is mainly seen in people who have travelled overseas including to parts of Africa, Asia, South America, the Middle East and the Pacific islands. *Vibrio cholerae* is found in the faeces of infected people, and is usually acquired by drinking contaminated water, eating food washed with contaminated water or prepared with contaminated hands, or eating fish or shellfish harvested from contaminated water. Person-to-person spread of cholera is less common. Symptoms typically start between two hours and five days after ingesting the bacteria. Symptoms can include characteristic 'rice water' faeces (profuse, watery diarrhoea); nausea and vomiting; and signs of dehydration, such as weakness, lethargy and muscle cramps. Infection without symptoms or with only mild symptoms may occur, particularly in children.

Surveillance data includes confirmed cases only. A confirmed case requires laboratory definitive evidence of isolation of toxigenic *Vibrio cholerae* O1 or O139.[vii] All notified cases are followed up by jurisdictional public health staff.

Overall trend

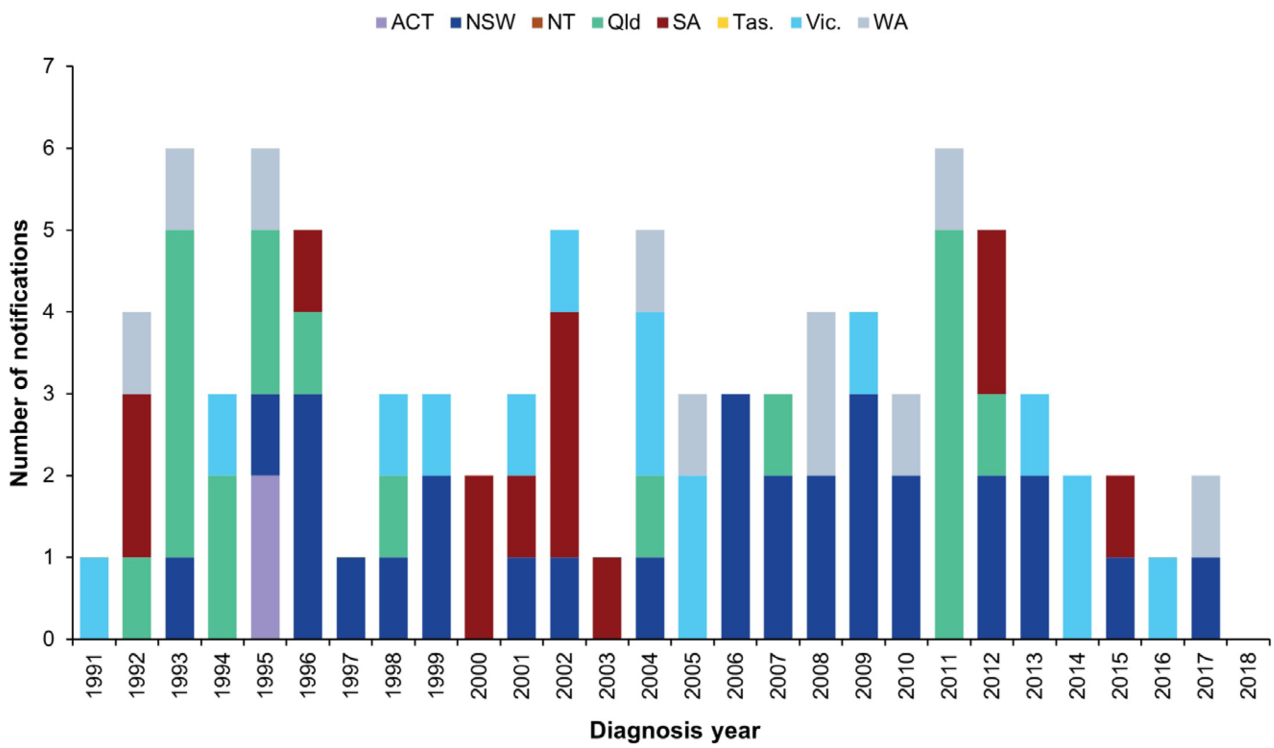
All cases of cholera reported since 1991 were acquired outside Australia, with the exception of:

- one laboratory acquired case in 1996;[12]
- three cases in 2006 linked to imported whitebait;[13] and
- one laboratory-acquired case in 2013.[14]

Epidemiology of cholera in Australia, 2018

There were no cases of cholera reported in 2018. The five-year average of cholera notifications was 2 cases per year between 2013 and 2017.

Figure 4: Cholera notifications in Australia by jurisdiction of residence, 1991–2018



vii Cholera case definition: https://www.health.gov.au/resources/publications/cholera-surveillance-case-definition.

Enteric fever

Typhoid and paratyphoid fever are grouped together as enteric fever as both diseases cause a similar illness, though paratyphoid fever is less common and often less severe. Symptoms include high fever, headache and malaise and may result in a serious bloodstream infection. Typhoid fever is caused by the bacterium S*almonella enterica* subsp. *enterica* ser. Typhi (*S*. Typhi), while paratyphoid fever is caused by *Salmonella enterica* subsp. *enterica* ser. Paratyphi (*S*. Paratyphi) not including *S*. Paratyphi B biovar Java. These infections are different to the gastroenteritis infection caused by other *Salmonella enterica* subsp. *enterica* serovars. Enteric fever is rarely acquired in Australia, with the majority of notified infections acquired in resource-poor countries with poor sanitation, hand hygiene and food handling standards, and untreated drinking water. People who travel to countries where enteric fever is endemic, to visit friends or family, have been recognised as a risk group for infection in Australia.[15,16] Consumption of ready-to-eat foods, especially raw fruits, vegetables, and shellfish, as well as drinking potentially contaminated water in countries where typhoid and paratyphoid are endemic, puts travellers at the greatest risk of infection.

Surveillance data includes confirmed cases only. A confirmed case requires laboratory definitive evidence of typhoid or paratyphoid infection.[viii,ix] All notified cases are followed up by jurisdictional public health staff.[x]

Overall trend

- Given that infections are almost always acquired outside Australia, notification rates are influenced by the incidence of disease in endemic countries and the number of people who travel to these destinations.
- The incidence of enteric fever in Australia has increased since notification began in 1991 (Figure 5).
- The incidence of paratyphoid fever has been steady over recent years, with the rate remaining around 0.3 cases per 100,000 population between 2011 and 2018 (Figure 5).
- Minor fluctuations in typhoid fever notifications have occurred in recent years; however, there is an overall increasing trend of incidence from 1991. There was a slightly higher rate observed in 2018 (0.7 cases per 100,000 population) than in 2017 (0.6 cases per 100,000) (Figure 5).
- With the exception of 2004, the annual count and rate of typhoid infections has exceeded that of paratyphoid (Figure 5).

Previous outbreaks in Australia

- The last major locally acquired typhoid outbreak occurred in Victoria in 1977 (n = 37 cases associated with a food handler who was a chronic carrier).[17]
- No enteric fever foodborne outbreaks have been recorded in Australia since OzFoodNet was established in 2000.
- Outbreaks resulting from transmission within households have been reported in Australia, and secondary transmission from a chronic carrier within a household setting is not uncommon. However, the exact mode or transmission from the chronic carrier is rarely able to be determined.[18]

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viii Typhoid fever case definition: https://www.health.gov.au/resources/publications/typhoid-fever-surveillance-case-definition.

ix Paratyphoid fever case definition: https://www.health.gov.au/resources/publications/paratyphoid-surveillance-case-definition.

x CDNA national guidelines for public health units. Typhoid and paratyphoid fevers: https://www.health.gov.au/resources/publications/typhoid-and-paratyphoid-cdna-national-guidelines-for-public-health-units.

Figure 5: Typhoid fever and paratyphoid fever notifications and enteric fever notification rate per 100,000 population in Australia, 1991–2018

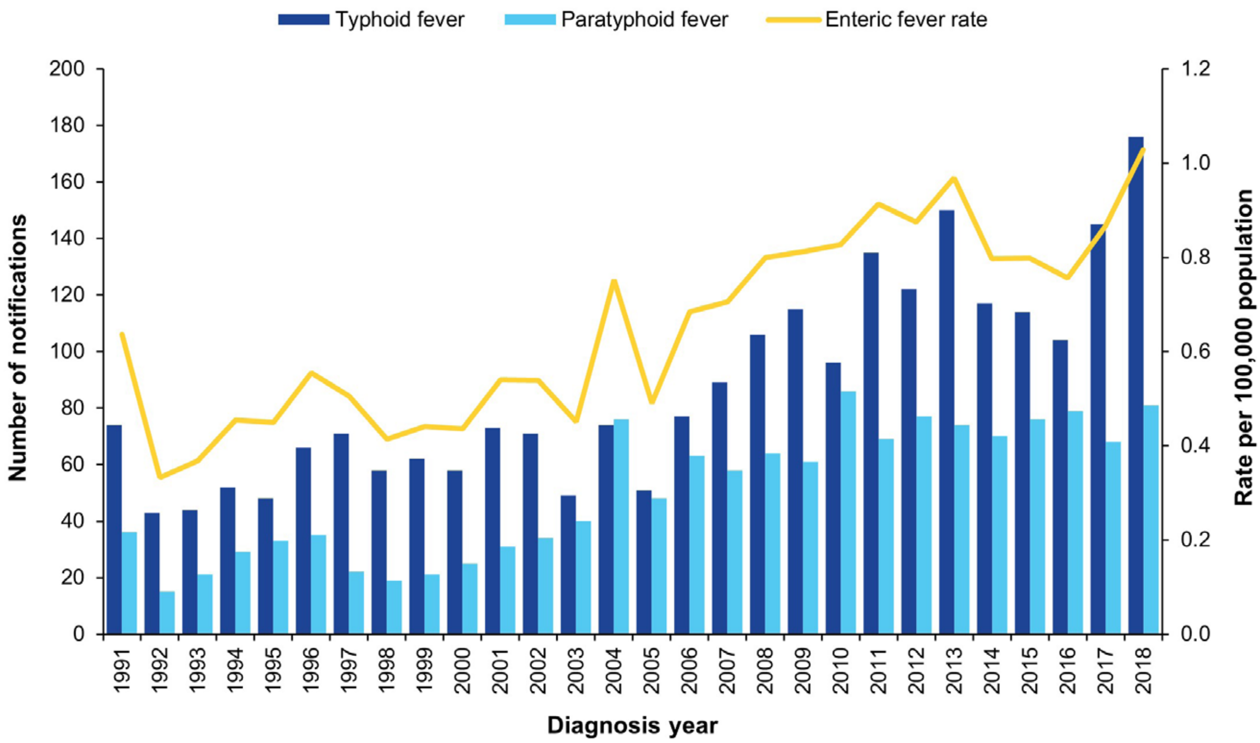

Figure 6: Typhoid fever notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2018

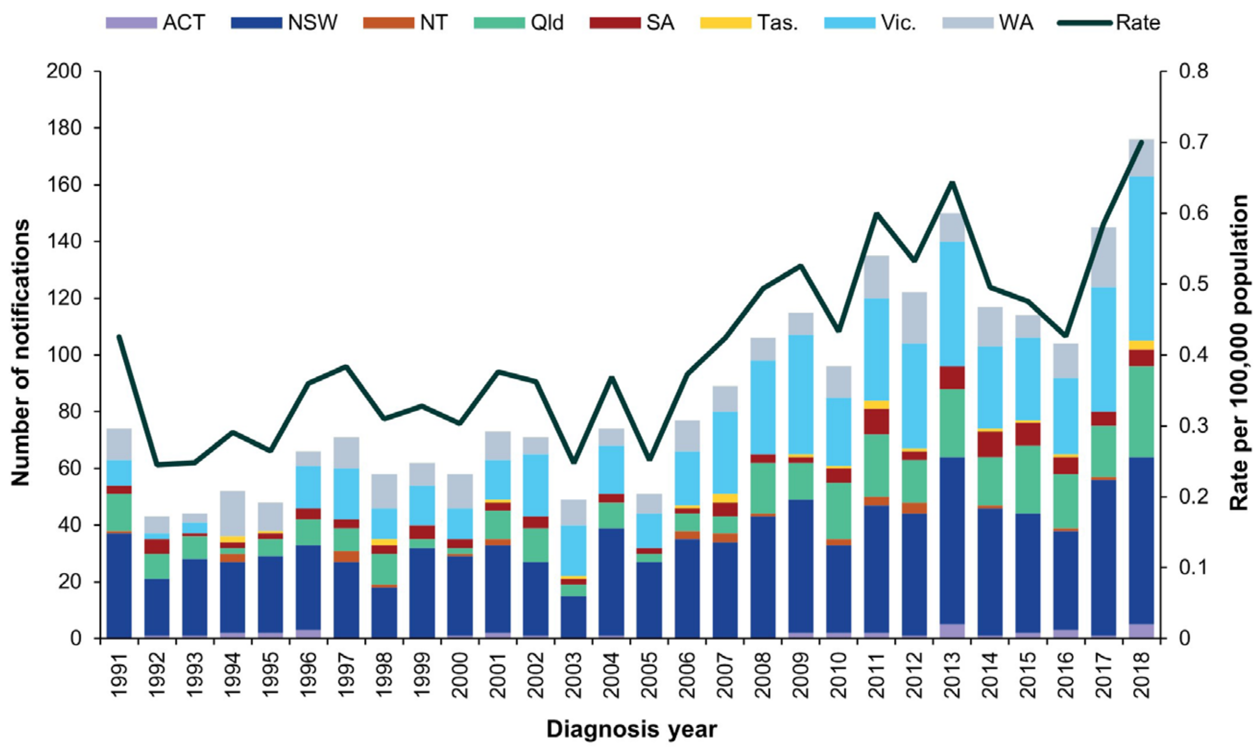

Figure 7: Paratyphoid fever notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2018

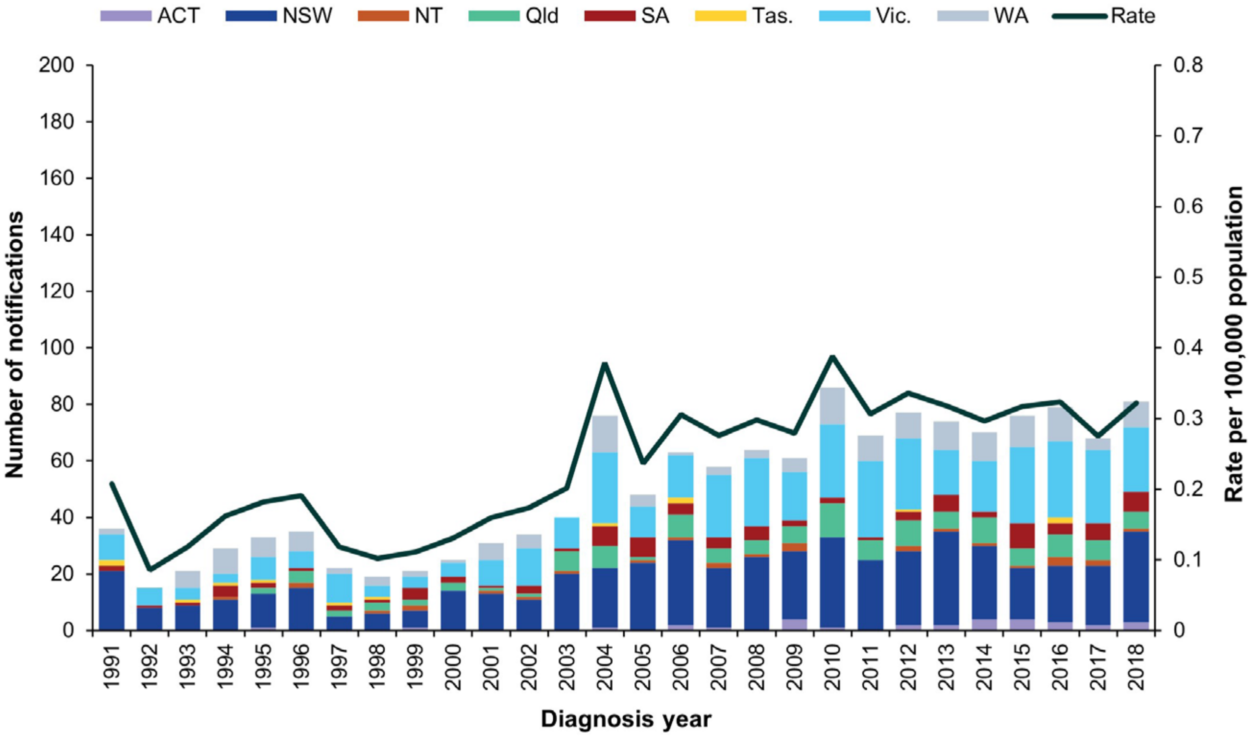

Table 4: Summary of enteric fever notifications in Australia, 2018

Category	Typhoid fever	Paratyphoid fever
Number of notifications	176	81
Rate per 100,000 population	0.7 cases	0.3 cases
Jurisdiction with highest number of notifications	New South Wales (n = 59; 34%)	New South Wales (n = 32; 40%)
Hospitalisations (% of all cases)	125 (71%)	50 (62%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	0	0
Foodborne outbreaks	0	0

a Indigenous status was not known for one paratyphoid and seven typhoid cases.

Epidemiology of enteric fever in Australia, 2018

- The numbers of typhoid and paratyphoid cases notified in Australia in 2018 were each higher than their respective five-year average number of notifications of 126 and 73 respectively (Table 1). There was a 21% increase in enteric fever notifications from 2017 (n = 213) to 2018 (n = 257).
- More than 60% of typhoid cases notified in 2018 were male (n = 107; 61%), while the sex distribution for paratyphoid cases was almost equivalent (males: n = 41; 51%).
- The median age at onset was 29 years for typhoid cases (range 0–72 years) and 27 years for paratyphoid cases (range 0–66 years). Those aged between 25 and 35 years had the highest number of notifications for both typhoid and paratyphoid fever, accounting for 33% (n = 58) and 38% (n = 31) of cases respectively.

- Consistent with previous years, the majority of typhoid cases were phage type E1 (n = 39; 22%) followed by phage type E9 (n = 9; 5%) and phage type 28 (n = 8; 5%). Phage typing was unknown or unable to be performed for 106 cases (60%).
- The majority of paratyphoid cases were Paratyphoid A (n = 74; 91%) with the remaining cases Paratyphoid B (n = 7; 9%), which was consistent with previous years.

Country of acquisition

- As seen in previous years, almost all enteric fever cases in 2018 were acquired outside of Australia, with 89% of typhoid cases (n = 157/176) and 98% of paratyphoid cases (n = 79/81) with available information reporting overseas travel during their incubation period.
- India was the most commonly reported country of acquisition for both typhoid and paratyphoid fever cases (Table 5).
- In 2018, there were 19 cases of typhoid reported to have been acquired locally in Australia. This was higher than in previous years. These cases did not have a history of overseas travel within their incubation period; however, most acquired their infections through household contact with overseas travellers.
- Australian-acquired typhoid cases were reported in Victoria (n = 8, including four cases with household exposure, and one case established as a chronic carrier); Queensland (n = 5, including four with household exposure to a case or symptomatic overseas traveller, one with an unknown source); New South Wales (n = 4, including one case with household exposure to a case who had previously travelled overseas); Tasmania (n = 1, unknown source); and Western Australia (n = 1, household exposure to a case).
- There were two cases of Australian-acquired paratyphoid reported in 2018, with one case in South Australia (no source identified after household screening) and one case in New South Wales (unknown exposure).

Table 5: Top three countries of acquisition for overseas-acquired enteric fever cases in Australia, 2018

Disease	Country of acquisition	Number of notifications, 2018[a]	Proportion of overseas-acquired cases, 2018[a]	Mean 2013–2017
Typhoid fever	India	97	63%	68
	Pakistan	13	8%	10
	Bangladesh	12	8%	11
Paratyphoid fever	India	39	50%	27
	Pakistan	12	15%	7
	Bangladesh	6	8%	4

a Excluding typhoid and paratyphoid cases acquired overseas but with an unknown country of acquisition (n = 4 and n = 1 respectively).

Hepatitis A

Hepatitis A is an infection of the liver caused by the hepatitis A virus (HAV) that is almost always transmitted by the faecal-oral route.

During the 1990s in Australia, groups most at risk of HAV infection were overseas travellers, childcare centre attendees, Aboriginal and/or Torres Strait Islander communities, men who have sex with men (MSM) and people who use or inject illicit drugs. Since the introduction of a vaccine into Australia in the mid-1990s and the subsequent implementation of vaccination programs and vaccine recommendations for at-risk groups,[xi] the majority of HAV infections diagnosed in Australia have been acquired while travelling overseas.[19] Foodborne transmission occurs rarely, although in 2009, 2015, 2017 and 2018 there were significant multi-jurisdictional foodborne outbreaks associated with the consumption of imported food (see *Previous outbreaks in Australia* section below).

Surveillance data includes confirmed and probable cases. A confirmed case requires laboratory definitive evidence of hepatitis A infection, and a probable case requires clinical and epidemiological evidence of infection.[xii] On 1 January 2013, the HAV case definition was amended to include a requirement for confirmed cases to have clinical evidence if laboratory evidence was only suggestive of HAV infection (HAV immunoglobulin M [IgM] positive) and there was no epidemiological evidence. This has enabled jurisdictions to reject cases that are likely to have a false positive HAV IgM.

All notified cases are followed up by jurisdictional public health staff.[xiii] In July 2017, enhanced national surveillance for hepatitis A commenced. This involves genomic sequencing of viruses from all HAV cases in Australia and collecting information on risk factors. Reporting on enhanced national surveillance has been included in the 2018 report.

Overall trend

- The incidence of HAV has markedly declined in Australia since notification began (Figure 8).
- The rate of HAV in 2018 (1.7 cases per 100,000 population) was almost twice as high as the rate of HAV reported in 2017 (0.9 cases per 100,000 population).
- The number of HAV cases reported in 2018 (n = 434) was 2.3 times as high as the five-year historical mean (n = 193). This was driven by an increase in the number of notifications reported in Victoria (three times as high as 2017) due to an ongoing person-to-person outbreak within Australia.

Previous outbreaks in Australia

Significant foodborne outbreaks previously reported in Australia have been associated with the consumption of:

- oysters (n = 547 cases) predominantly in New South Wales in 1997;[20]
- imported semi-dried tomatoes (n = 291 cases) in multiple jurisdictions in 2009;[21]
- imported frozen berries (n = 35 cases) in multiple jurisdictions in 2015;[5] and
- imported frozen mixed berries (n = 11 cases) in multiple jurisdictions in 2017.[4]

In addition to foodborne outbreaks, non-foodborne HAV outbreaks have also been reported in Australia amongst men who have sex with men (MSM); people who use or inject illicit drugs; people experiencing homelessness; childcare centre attendees; and family groups, often where the index case has acquired their infection overseas.

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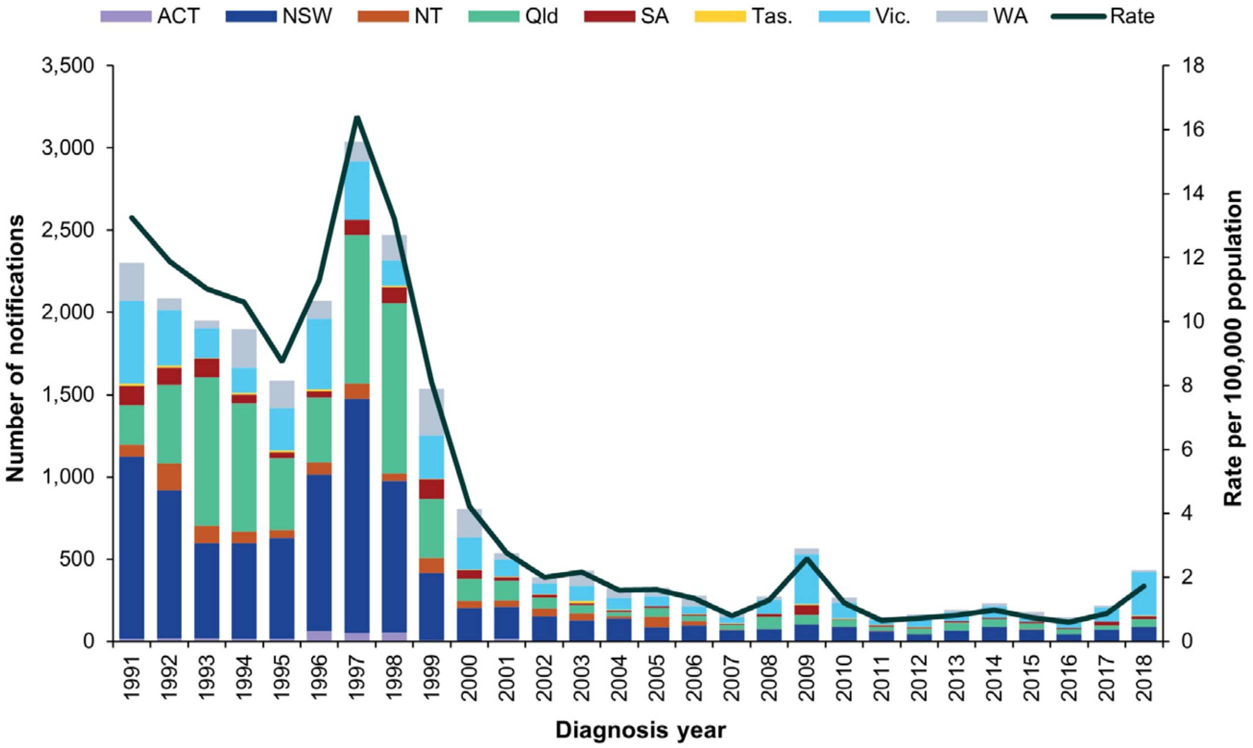
xi Including Aboriginal and/or Torres Strait Islander children in northern Queensland commencing in 1999 and expanding in 2005 to all Indigenous children less than two years of age in Queensland, the Northern Territory, Western Australia and South Australia.

xii Hepatitis A case definition: https://www.health.gov.au/resources/publications/hepatitis-a-surveillance-case-definition.

xiii Hepatitis A National Guidelines for Public Health Units: https://www.health.gov.au/resources/publications/hepatitis-a-cdna-national-guidelines-for-public-health-units.

Figure 8: HAV notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2018



Epidemiology of HAV in Australia, 2018

Table 6: Summary of HAV notifications in Australia, 2018

Category	Value
Number of notifications	434
Rate per 100,000 population	1.7 cases
Jurisdiction with the highest number of notifications	Victoria (n = 264; 61%)
Hospitalisations (% of all cases)	226 (52%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	10 (2%)
Foodborne outbreaks[b]	1 (n = 31 cases) linked to imported frozen pomegranate arils

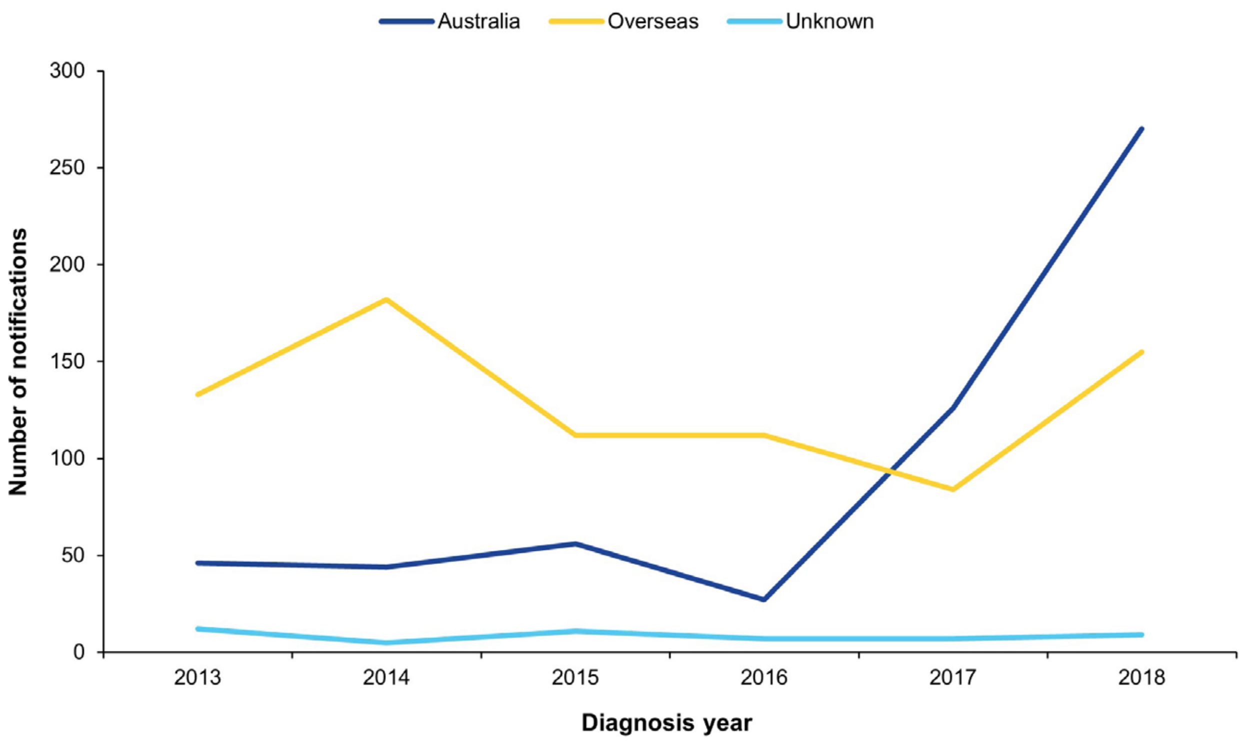
a Indigenous status was not known for 33 cases (8%).

b Refer to *Foodborne outbreaks* section.

Country of acquisition

Australian-acquired cases in 2018 exceeded the number of overseas-acquired cases in 2018, continuing the trend seen in 2017. This is likely due to an ongoing HAV outbreak among MSM and a multi-jurisdictional foodborne outbreak in 2018 (described further below). The number of overseas-acquired HAV infections remained relatively steady during 2018; however, the number of Australian-acquired cases in 2018 (n = 273) was 4.5 times as high as the five-year historical mean (n = 60) (Figure 9).

Figure 9: HAV notifications in Australia by place of acquisition, 2013–2018



HAV cases acquired in Australia 2018 (n = 271)

- Most cases acquired in Australia were in males (n =189; 70%), with infections most commonly reported by those aged 20–49 years (n = 127; 67%). In females, cases were most common among those aged 15–19 years (n = 9; 11%) and 40–44 years (n = 10; 12%).
- Cases were reported in residents of Victoria (n = 203; 74%), New South Wales (n = 34; 12%), Queensland (n = 15; 6%), South Australia (n = 11; 4%), Western Australia (n = 4; 1%), the Northern Territory (n = 2; 1%), Tasmania (n = 1) and the Australian Capital Territory (n = 1).
- Of all cases acquired in Australia, eight were reported amongst Aboriginal and/or Torres Strait Islander people.

HAV cases acquired overseas (n = 161)

- Over half of the overseas-acquired cases were male (n = 93; 58%).
- The most frequently reported age group affected was those aged 25–34 years (n = 46; 29%).
- HAV infection was most commonly acquired in India, accounting for 24% of all overseas-acquired cases (Table 7).

Table 7: Top three countries of acquisition for overseas acquired HAV cases in Australia, 2018 (n = 161)

Country of acquisition	Number of notifications, 2018	Proportion of overseas acquired cases, 2018[a]	Mean 2013–2017
India	39	24%	20
Pakistan	12	7%	11
Lebanon	10	6%	6

a Excluding cases known to be overseas acquired without a single identified country of acquisition (n = 2).

Outbreak amongst men who have sex with men

A national investigation initiated in 2017, following an increase in HAV cases with no history of overseas travel,[4] continued into 2018. Cases who had spent some of their acquisition period (15 to 50 days prior to onset of illness) in Australia and who were identified as having one of three strains related to the large, multi-country outbreak in Europe (UK VRD 521 2016 (UK strain), RIVM-HAV16-090 (Ber/NL strain) and V16-25801 (Ber/Muc/Fra strain)) were included in the investigation.[22]

There were 98 cases linked to the outbreak with symptom onset in 2017, with cases occurring predominantly in males who identified as MSM. In 2018 the number of cases in the outbreak increased, with 214 cases linked to the outbreak across Australia. Cases were reported in Victoria (n = 188), New South Wales (n = 11), South Australia (n = 8), Queensland (n = 4), Western Australia (n = 2) and Tasmania (n = 1). Most cases in the outbreak were male (n = 164; 77%) and, where data was available, nearly all male cases identified as MSM (n = 86/98; 88%). The male-to-female ratio of cases in the outbreak in 2018 was 3.3:1, a decrease from 18.2:1 in 2017. Eight percent of outbreak cases in 2018 reported overseas travel (n = 17) including to countries experiencing similar outbreaks with identification of risk factors including MSM. In Australia, one-fifth of cases reported injecting drug use (n = 41; 19%). In response to the outbreak, affected jurisdictions implemented public health messaging and vaccination campaigns targeted to specific at-risk groups (including MSM and injecting drug users). The outbreak continued into 2019.

Hepatitis E

Hepatitis E is an infection of the liver caused by the hepatitis E virus (HEV) that is almost always transmitted by the faecal-oral route. Infections are rarely notified in Australia and are usually associated with overseas travel. HEV infections acquired in Australia are occasionally notified and some of these infections have been associated with the consumption of undercooked pork products, particularly pork livers.[23] HEV has been found in pig herds in Australia.[24]

Surveillance data includes confirmed cases only. A confirmed case requires either laboratory definitive evidence or laboratory suggestive and clinical evidence of HEV infection.[xiv] Testing practices for HEV vary across jurisdictions. All notified cases are followed up by jurisdictional public health staff.

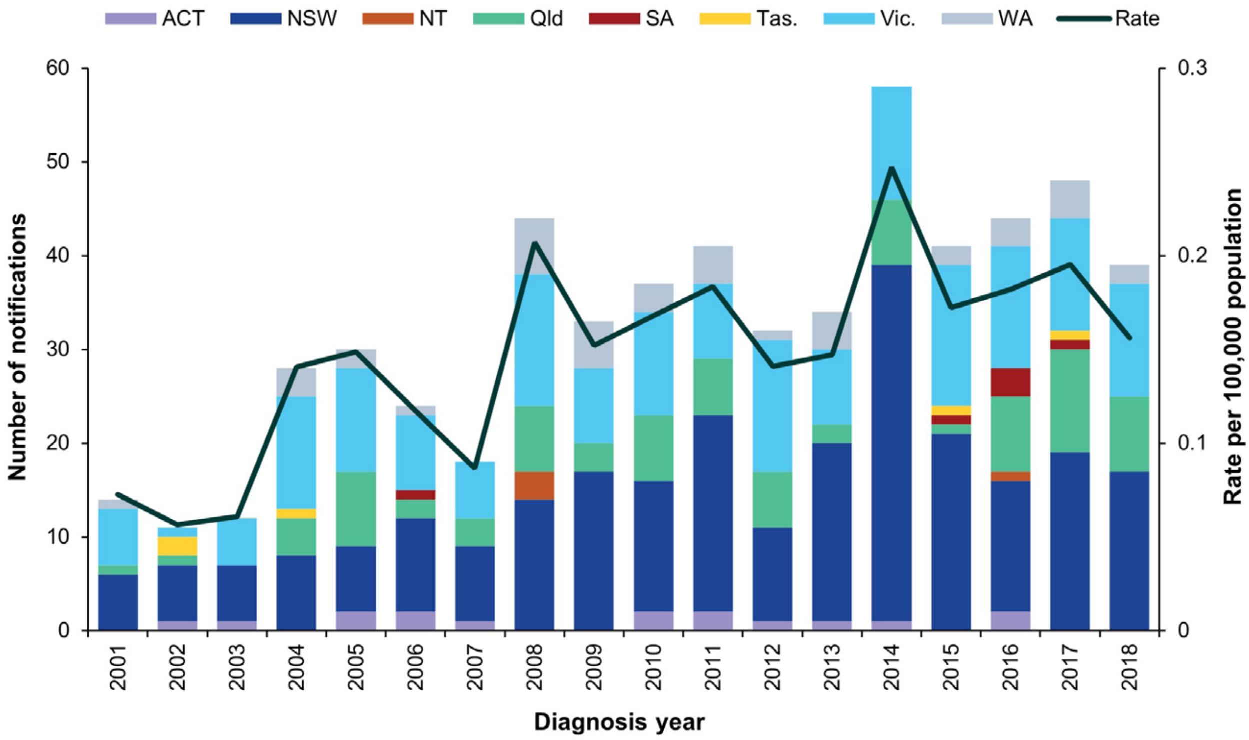
Overall trend

- While HEV infection is rare in Australia, notification rates have trended upwards since national notification began in 2001, peaking in 2014 due to a local foodborne outbreak (Figure 10).
- The number of notifications decreased by 19% in 2018 (n = 39) compared to 2017 (n = 48). The number of notifications in 2018 was lower than the five-year historical mean of 45 cases.

Previous outbreaks in Australia

A foodborne outbreak in New South Wales, following the consumption of pork liver pâté in 2014 (n = 17 cases), is the only known outbreak of HEV to have occurred in Australia.[23]

Figure 10: HEV notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2018



xiv Hepatitis E case definition: https://www.health.gov.au/resources/publications/hepatitis-e-surveillance-case-definition.

Epidemiology of HEV in Australia, 2018

Table 8: Summary of HEV notifications in Australia, 2018

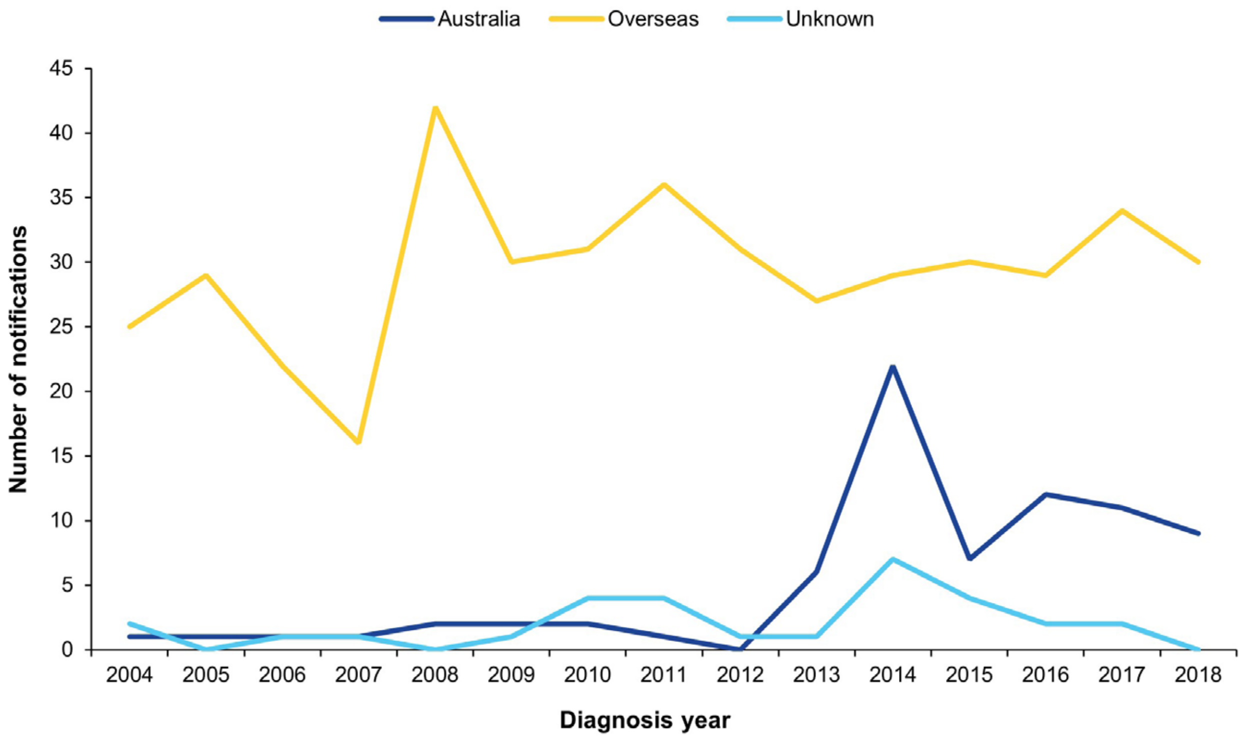
Category	Value
Number of notifications	39
Rate per 100,000 population	0.2 cases
Jurisdiction with the highest number of notifications	New South Wales (n = 17; 44%)
Hospitalisations (% of all cases)	27 (69%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	0
Foodborne outbreaks	0

a Indigenous status was not known for one case (3%).

Country of acquisition

- From 2004 (when travel history has been collected nationally) until 2013, almost all HEV infections were acquired overseas (Figure 11).
- While overseas travel continues to account for the majority of cases since 2013, an increased number of Australian-acquired infections have been reported, compared to prior years (Figure 11).

Figure 11: HEV notifications in Australia by place of acquisition, 2004–2018



HEV cases acquired overseas (n = 30)

- Consistent with previous years, the majority of HEV cases diagnosed in Australia were acquired overseas (30/39; 77%).
- HEV infection was most commonly acquired in India (Table 9).
- Most cases acquired overseas were males (19/30; 63%), with a median age of 39 years (range 20–70 years).

Table 9: Top four countries of acquisition for overseas-acquired HEV cases in Australia, 2018 (n = 30)

Country of acquisition	Number of notifications, 2018	Proportion of overseas acquired cases, 2018	Mean 2013–2017
India	13	43%	13
Bangladesh	6	20%	2
Pakistan	2	7%	3
Thailand	2	7%	1

HEV cases acquired in Australia (n = 9)

- Cases were residents of New South Wales (n = 5), Queensland (n = 3) and Victoria (n = 1).
- While the source of infection was not identified for these cases, food consumption data was available for six of the nine Australian-acquired cases. During their incubation periods, five cases reported eating pork products, including pork liver, and one case reported eating goat meat.
- The majority of cases acquired in Australia were males (n = 7; 78%), and the median age was 54 years (range 30–82 years).

Listeriosis

Listeriosis is a rare but serious illness caused by the *Listeria monocytogenes* bacterium. Infection occurs following the consumption of contaminated food or, in the case of a foetus or newborn, vertically from their pregnant mother. A wide variety of foods may be contaminated with *L. monocytogenes*, but cases of listeriosis are predominantly associated with commercially manufactured ready to eat foods that have a long recommended refrigerated shelf-life and fresh foods that are consumed fresh or without further cooking, for example cold meats (from delicatessen or pre-packaged), cold cooked chicken, pâté, pre-packaged salads, fresh fruits such as rockmelon, chilled cooked seafood, smoked fish and soft cheeses.[25] The elderly, pregnant women, and people who are immunocompromised (either by medical condition or medications) are at an increased risk of infection.[26]

Surveillance data includes confirmed cases only. The case definition was expanded from 1 January 2017 to include clinical and epidemiological evidence as criteria for a confirmed case (in addition to laboratory definitive evidence). The clinical and epidemiological evidence criteria for a confirmed case means that if the mother is a confirmed case by laboratory definitive evidence, then the foetus/neonate is also a confirmed case if they have the defined (foetus/neonate) clinical evidence, and vice versa.[xv] All notified cases are followed up by jurisdictional public health staff.[xvi]

Overall trend

- With the exception of increases due to outbreaks in 2009 and 2012–2013, the rate of listeriosis in Australia has remained steady since national notification began in 1994 (Figure 12).
- There was a multijurisdictional listeriosis outbreak attributed to rockmelon in 2018; however, the rate of listeriosis in 2018 has remained unchanged from 2017. For more information on multijurisdictional outbreaks please refer to the *Foodborne outbreaks* section.

Previous outbreaks in Australia

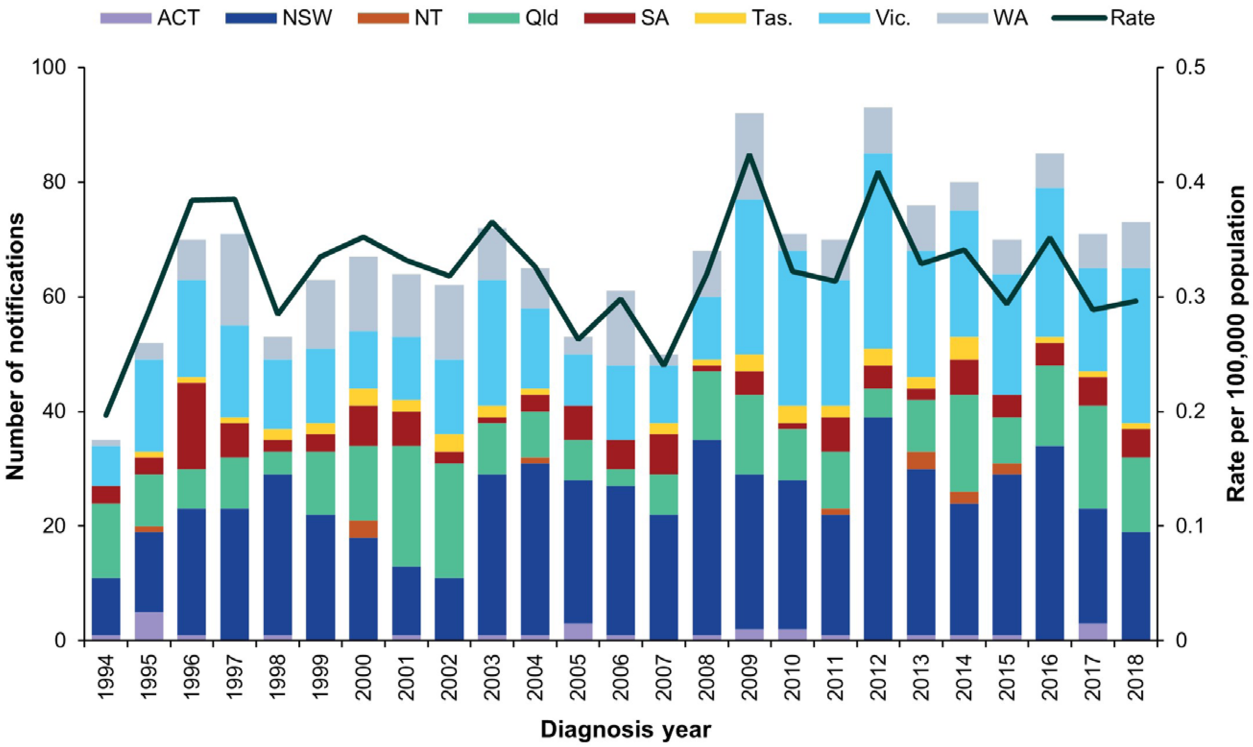
Cases are usually sporadic, although foodborne outbreaks have been reported in Australia. Food sources of significant outbreaks identified in Australia since 2000 include:

- ready-to-eat meats (silverside, corned beef) (n = 5 cases) in South Australia in 2005;[27]
- cooked chopped chicken (n = 3 cases) in Western Australia in 2009;[28]
- chicken wraps (n = 36 cases) in multiple jurisdictions in 2009;[29]
- melons (n = 9 cases) in multiple jurisdictions in 2010;[30]
- cold meat (n = 6 cases) in Victoria in 2010;
- smoked salmon (suspected) (n = 3 cases) in multiple jurisdictions in 2012;[31]
- soft cheese (brie/camembert) (n = 34 cases) in multiple jurisdictions in 2012–2013;[32,33]
- profiteroles (n = 3 cases) in New South Wales in 2013;[34,35]
- pre-prepared frozen meals (n = 3 cases) in Western Australia in 2013; and
- deli meats (n = 8) in multiple jurisdictions in 2016.[3]

xv Listeriosis case definition: https://www.health.gov.au/resources/publications/listeriosis-surveillance-case-definition.

xvi CDNA national guidelines for public health units. Listeriosis: https://www.health.gov.au/resources/publications/listeriosis-cdna-national-guidelines-for-public-health-units.

Figure 12: Listeriosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1994–2018



Epidemiology of listeriosis in Australia, 2018

Table 10: Summary of listeriosis notifications in Australia, 2018

Category	Value
Number of notifications	74, comprising 64 non-perinatal cases and 10 perinatal cases
Rate per 100,000 population	0.3 cases
Hospitalisation (% of all cases)	74 (100%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	2 (3%)
Jurisdiction with the highest number of notifications	Victoria (n = 27; 36%)
Foodborne outbreaks	2 (n = 27 cases)
Food implicated in outbreak	Rockmelon was implicated in one outbreak (24 cases), the other source was unknown.

a Indigenous status was not known for three cases (4%).

MLST typing

Multi-locus sequence typing (MLST) is determined *in silico* from whole genome sequencing data, as part of the NELSS. A total of 23 different MLST types were reported from case isolates in 2018. The most common type identified was MLST 240 which accounted for a third of all cases, most of which were associated with a multijurisdictional outbreak (Table 11; see also the *Foodborne outbreaks* section). During 2010–2017, MLST 240 was a rare MLST with an average occurrence of one case per year.

Table 11: Listeriosis cases in Australia by multi-locus sequence typing (MLST), 2018[a,b]

MLST	Number of cases	Proportion
240	21	30%
3	11	16%
1	9	13%
7	4	6%
2	3	4%
204	2	3%
321	2	3%
323	2	3%
87	2	3%
14	1	1%
1506	1	1%
155	1	1%
202	1	1%
220	1	1%
224	1	1%
299	1	1%
4	1	1%
455	1	1%
54	1	1%
6	1	1%
648	1	1%
8	1	1%
9	1	1%
Total	**70**	**100%**

a Excluding cases with isolates not typed (n = 1), and maternal/foetal infection counted once only (n = 3).

b Data taken from NELSS.

Perinatal cases (n = 10)

- There were ten perinatal cases notified in 2018.
- Of these cases, seven cases were pregnant women and three were neonates (infants less than four weeks of age).
- There were three mother/neonate pairs notified (representing six notifications) and four notifications in the mother only.
- The outcome of the seven pregnancies were: continuing pregnancy (n = 1); miscarriage (n = 2);[xvii] neonatal death (n = 2);[xviii] and neonatal survival (n = 2).
- There were no deaths reported in the pregnant women.
- Clinical presentations reported for the mother included bacteraemia/sepsis (n = 5) and non-specific ‘flu-like’ symptoms (n = 1). Two cases reported no symptoms.

xvii Miscarriage is defined as foetal death at less than 20 weeks gestation.

xviii Neonatal death is defined as foetal death at greater than or equal to 20 weeks gestation.

Non-perinatal cases (n = 64)

- The median age of non-perinatal cases was 79 years (range 40–98 years). The majority of cases (n = 56; 88%) were aged over 65 years, with 47% (n = 30) aged over 80 years.
- Females accounted for approximately half of the cases (n = 33; 52%).
- The most common clinical presentation of non-perinatal listeriosis cases was septicaemia (n = 55; 86%) (Table 12).
- Thirty-three cases (52%) had at least one illness/condition known to increase their risk of listeriosis infection, with heart disease (n = 27) and cancer (n = 27) the most commonly reported (Table 13).
- There were four cases with no known comorbidities, with none of these cases reporting taking medications including corticosteroids, cyclosporine, or antibiotics in the four weeks prior to illness.
- Ten cases died, all of whom had septicaemia. Nine deaths were specifically attributed to listeriosis.

Table 12: Non-perinatal listeriosis cases by clinical presentation in Australia, 2018[a] (n = 64)

Nature of the illness	Number of cases	Proportion of all cases (%)	Deaths
Septicaemia	55	86%	10
Meningitis and septicaemia	0	—	0
Meningitis	2	3%	0
Other[b]	5	8%	0
Unknown	2	3%	0
Total	**64**	**100%**	**10**

a Data taken from NELSS.

b ‘Other’ includes: gastroenteritis and confusion; meningoencephalitis; spontaneous bacterial peritonitis; and no details provided.

Table 13: Immunocompromising conditions for non-perinatal listeriosis cases in Australia, 2018[a] (n = 64)

Condition	Number of cases	Proportion of all cases (%)
Cancer	27	42%
Diabetes	18	28%
Heart disease	27	42%
Chronic lung disease (excluding asthma)	5	8%
Renal disease not requiring dialysis	10	16%
Liver disease	8	13%
Blood disorder	5	8%
Renal / kidney disease requiring dialysis	8	13%
Rheumatological condition	13	20%
Organ transplant	1	2%
No immunocompromising conditions	4	6%

a Data taken from NELSS.

Salmonellosis

Salmonellosis is an infection caused by the *Salmonella* bacterium. It is second to campylobacteriosis as the most commonly notified enteric pathogen in Australia. *Salmonella* infections acquired in Australia are usually associated with consumption of contaminated food, or less commonly, after contact with infected animals or an infected person. Food sources associated with *Salmonella* infection in Australia include raw and undercooked foods of animal origin, particularly eggs and poultry, and fresh produce.[36,37] Infection can also occur following exposure to *Salmonella* in the environment. Many *Salmonella* infections are also notified in people returning from overseas.

Surveillance data includes confirmed cases only. A confirmed case requires laboratory definitive evidence of infection.[xix] Note that paratyphoid and typhoid fever infections are reported separately (refer to the *Enteric fever* section). Surveillance data is monitored by jurisdictional public health staff to identify potential outbreaks. Triggers for further investigation vary within and between jurisdictions depending on background infection rates, availability and timeliness of sub-typing information, and resource capacity.

Overall trend

- Salmonellosis notification rates have increased since national notification began in 1991 (Figure 13).
- There has been an increasing trend of notifications observed across most jurisdictions since 2014. This is due, at least in part, to the increase in PCR testing as a method of laboratory diagnosis (refer to the 2016 OzFoodNet annual report).[3]
- A slight decline in the notification rate was observed in 2018 compared to 2016 and 2017.

Previous outbreaks in Australia

Salmonellosis is the enteric pathogen most commonly identified in foodborne outbreaks in Australia. These outbreaks have been most frequently associated with the consumption of raw or minimally cooked egg products.[32,33] (Refer to *Foodborne outbreaks* section.)

S. Typhimurium is the most commonly identified serotype in *Salmonella* outbreaks reported in Australia. The foods implicated in the largest of these outbreaks include:

- Vietnamese bánh mì rolls (n = 213 cases) in Victoria in 2003;
- dips served at a Turkish restaurant (n = 442 cases) in Victoria in 2005;[38]
- pork or chicken and salad rolls made with raw-egg mayonnaise (n = 319 cases) in New South Wales in 2007;[39]
- chicken (n = 391 cases) in multiple jurisdictions in 2012;[40]
- potato salad containing raw eggs (n = 350 cases) in Queensland in 2013;[41]
- raw-egg mayonnaise (n = 242 cases) in Victoria in 2014; and
- numerous bakery items (n = 202 cases) in New South Wales in 2016.

Other notable foodborne *Salmonella* outbreaks reported in Australia include:

- *S*. Saintpaul associated with rockmelon (n = 38 cases) in multiple jurisdictions in 2006,[42] and mung bean sprouts (n = 419 cases) in multiple jurisdictions in 2016;[3]
- *S*. Litchfield associated with papaya (n = 26 cases) in multiple jurisdictions in 2006;[43]
- *S*. Anatum associated with bagged salads (n = 311 cases) in multiple jurisdictions in 2016;[3] and
- *S*. Hvittingfoss associated with rockmelons (n = 144 cases) in multiple jurisdictions in 2016.[3]

xix Salmonellosis case definition: https://www.health.gov.au/resources/publications/salmonellosis-surveillance-case-definition.

Notable non-foodborne outbreaks reported in Australia include:

- *S.* Paratyphi B biovar Java associated with tropical fish aquariums in 2003–2004;[44]
- *S.* Paratyphi B biovar Java associated with playground sand in New South Wales in 2007–2009;[45] and
- *S.* Litchfield associated with a Northern Territory car rally in 2009.[46]

Despite the number of salmonellosis outbreaks reported, the majority of salmonellosis cases reported annually are considered sporadic cases.

Figure 13: Salmonellosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2018

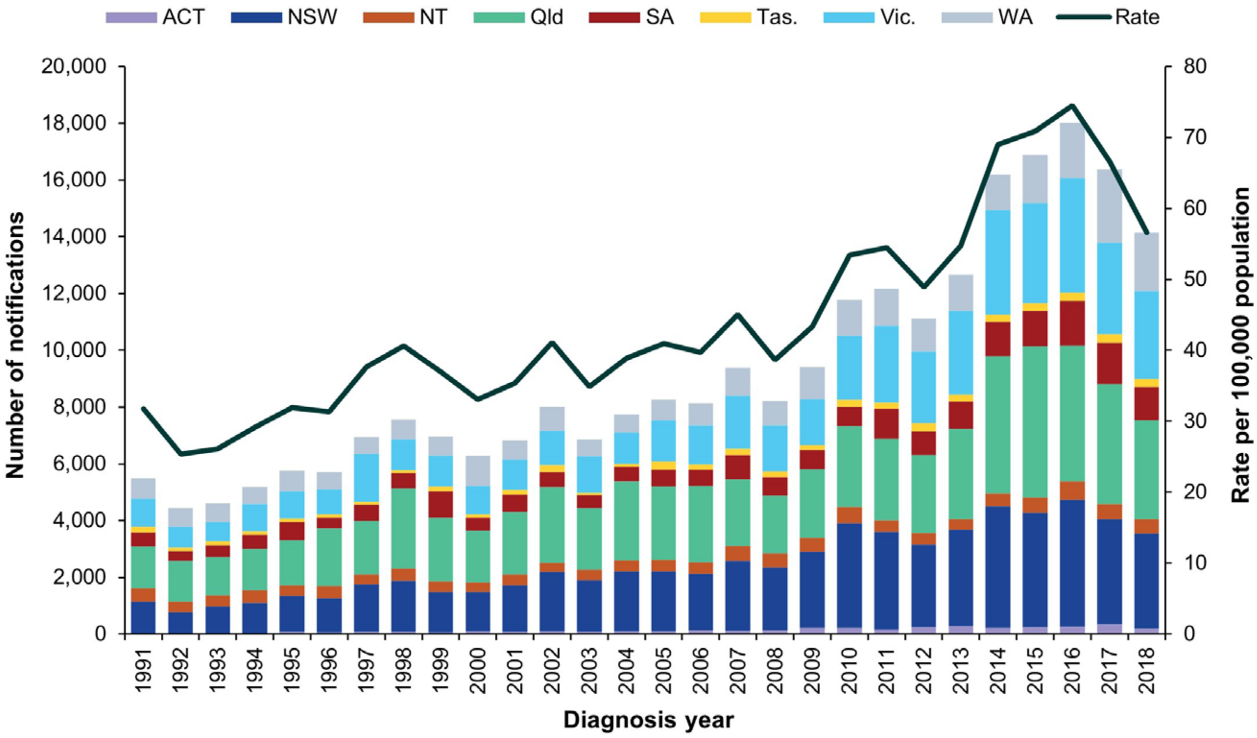


Table 14: Summary of salmonellosis notifications in Australia, 2018

Category	Value
Number of notifications	14,144
Rate per 100,000 population	57 cases
Jurisdiction with the highest number of notifications	Queensland (n = 3,481; 25%)
Foodborne outbreaks	71
Foods implicated in outbreaks[a]	Most commonly eggs (n = 26 outbreaks)

a Refer to *Foodborne outbreaks* section.

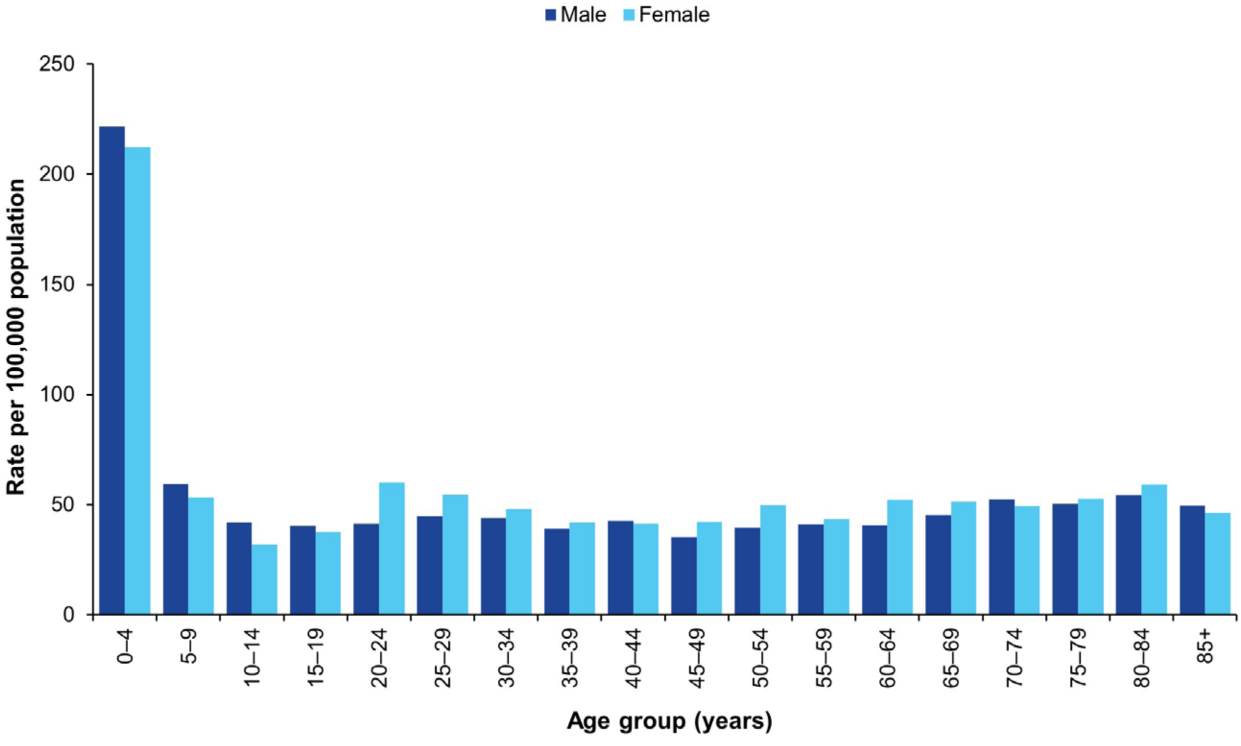
Table 15: Groups with the highest salmonellosis notification rate in Australia, 2018

Category	Group most affected	Rate per 100,000 population	Number (% of all cases)
Age group (years)	0–4	218	3,443 (24%)
Sex	Females	58	7,250 (51%)
Jurisdiction	Northern Territory	213	528 (4%)

Epidemiology of salmonellosis in Australia, 2018

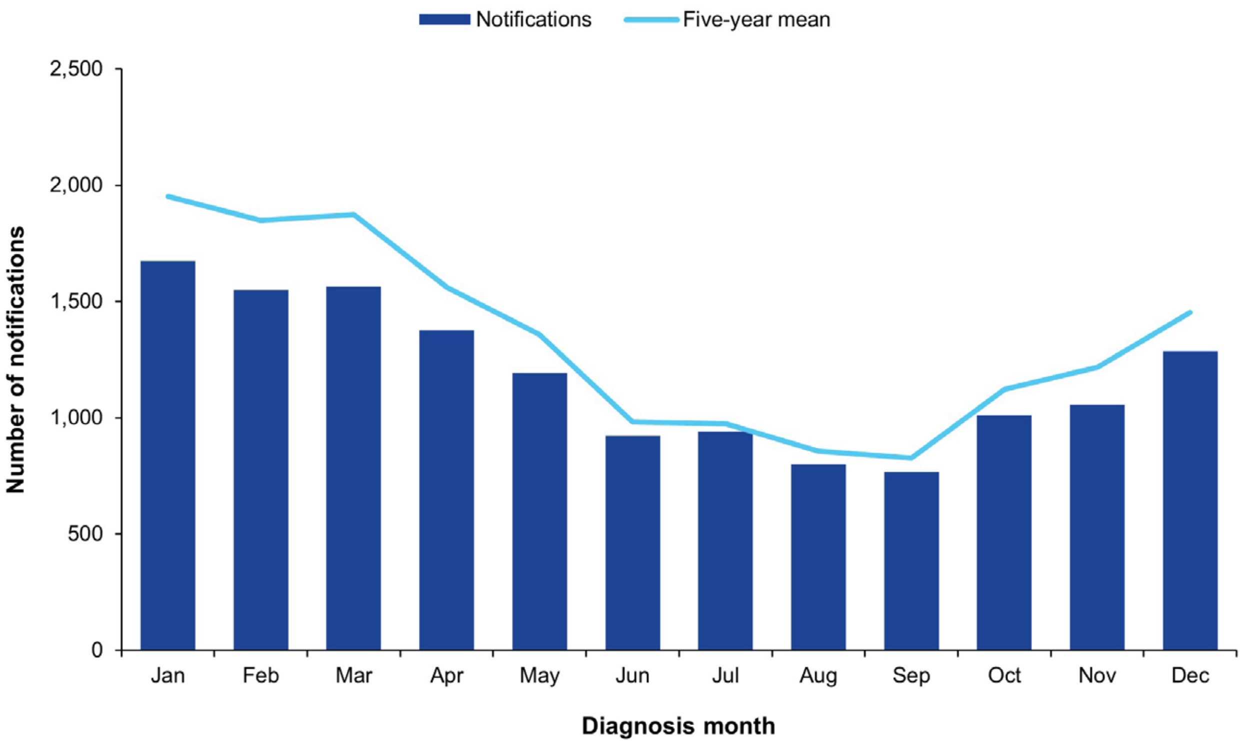
- There were 14,144 salmonellosis notifications in 2018, which was lower than the five-year historical mean of notifications (n = 16,024).
- The jurisdiction with the highest number of salmonellosis notifications in 2018 was Queensland (n = 3,481); however, the jurisdiction with the highest rate was the Northern Territory (213 cases per 100,000 population) (Table 15).
- Consistent with previous years, notifications were notably higher in children aged under five years than among all other age groups, accounting for 24% of all salmonellosis notifications in 2018 (Figure 14).
- Salmonellosis notifications were higher overall among females (n = 7,250; 51%) than among males (n = 6,870; 49%). This trend was reflected in most age groups, with the exception of those aged under 20 years and within the 70–74 years age group, where rates were higher among males (Figure 14).
- Approximately two-thirds of reported infections occurred in the summer and autumn months, with the highest monthly count reported in March (Figure 15).

Figure 14: Salmonellosis notification rate per 100,000 population in Australia by age group and sex,[a] 2018



a Excluding cases with sex not defined (n = 24).

Figure 15: Salmonellosis notifications in Australia by month, and five-year historical mean, 2018



Serotyping

Serotyping information was available for 89% of salmonellosis notifications in 2018 (n = 12,560/14,144), with a total of 212 different serotypes identified. The most common serotype identified in 2018 was *S*. Typhimurium, despite a 29% decrease in reported cases of this serotype (n = 4,622) compared to the five-year historical mean (n = 6,536). The five most commonly identified serotypes in 2018 are shown in Table 16; when combined, these serotypes account for 52% of all cases with serotyping performed.

Table 16: Top five *Salmonella* serotypes notified in Australia, 2018

Salmonella serotype	Number notified in 2018	% of all serotypes	Mean 2013–2017
S. Typhimurium	4,622	33%	6,536
S. Enteritidis	958	7%	872
S. Virchow	649	5%	710
S. Saintpaul	516	4%	649
S. Paratyphi B biovar Java	371	3%	348

Salmonella Typhimurium

With the exception of the Northern Territory, Tasmania and Queensland, *S*. Typhimurium was the most common serotype notified in each jurisdiction in 2018, with the highest notification rate reported in Western Australia (40 cases per 100,000 population) (Table 17). Isolates of *S*. Typhimurium routinely undergo the molecular-based further typing method of multiple-locus variable number tandem repeat analysis (MLVA).[xx]

A total of 854 distinct *S*. Typhimurium MLVA profiles were identified, with 706 of these accounting for fewer than five cases each over the year. In Western Australia and Tasmania a single MLVA profile accounted for more than a third of cases, while for the remaining jurisdictions the most common MLVA type accounted for approximately 10–15% of cases (Table 17). Refer to the *Foodborne outbreaks* section for details of *S*. Typhimurium outbreaks.

Table 17: *Salmonella* Typhimurium (STm) notifications by jurisdiction and most common multiple-locus variable number tandem repeat analysis (MLVA) type[a] in Australia, 2018 (n = 4,622)

	Total STm 2018			Most common MLVA		
Jurisdiction[b]	Annual count	Rate per 100,000 population	Number of MLVA types identified	MLVA type	Annual count	% of MLVA
ACT	80	19	32	04-11-12-00-517	19	30%
NSW	901	11	309	05-17-09-13-490	71	8%
NT	43	17	N/A[c]	N/A[c]	N/A[c]	N/A[c]
Qld	422	8.4	202	04-15-11-00-490	12	3%
SA	597	34	151	03-10-08-09-523	98	16%
Tas.	78	15	32	03-15-11-10-523	21	34%
Vic.	1,450	22	303	03-14-10-08-523	104	7%
WA	1,051	41	194	03-17-09-12-523	417	41%
Total	**4,622**	**19**	**854**	**03-17-09-12-523**	**445**	**10%**

a Excluding cases where MLVA type was not available (n = 178).

b ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

c Not reported, as MLVA type was unavailable for the majority of Northern Territory cases (n = 38; 88%).

Salmonella Enteritidis

S. Enteritidis is a globally important *Salmonella* serotype that can infect the internal contents of eggs. Previously *S*. Enteritidis was not considered endemic in Australian egg layer flocks.[47] In 2018, *S*. Enteritidis was detected in Australian poultry facilities in New South Wales for the first time.[48,49] For this reason, a travel history is sought from all notified cases, and cases who have not travelled outside Australia undergo further investigation to identify the likely source of infection.

In 2018, *S*. Enteritidis was the second most common *Salmonella* serotype reported across Australia, with a total of 958 *S*. Enteritidis case notifications. This was higher than in 2017 (n = 851) and higher than the five-year historical mean (n = 872). Consistent with previous years, the majority of cases with a known travel history reported overseas travel within their incubation period (n = 725; 75%), with approximately half reporting travel to Indonesia (n = 345; 48%). This may reflect travel practices rather than an increased risk.

xx Phage typing is no longer performed routinely in the majority of jurisdictions.

S. Enteritidis acquired in Australia (n = 167)

S. Enteritidis infections acquired in Australia (n = 167) were most commonly reported in New South Wales (n = 112; 67%), followed by Queensland (n = 23; 14%). In mid-2018, an investigation commenced into Australian-acquired cases of *S*. Enteritidis in New South Wales. This investigation evolved into a multi-jurisdictional outbreak investigation in 2019 and is reported in more detail in the 2019 OzFoodNet annual report.

Within broader *S*. Enteritidis investigations occurring in New South Wales in 2018, two point-source outbreaks were identified. One outbreak was associated with a restaurant and the other with a school camp. In both outbreaks, the contaminated food vehicle was not identified but the human cases were confirmed to be genomically linked to egg samples. Refer to the *Foodborne outbreaks* section for further information.

Shigellosis

Shigellosis is a diarrhoeal disease caused by the *Shigella* bacterium. In Australia, the most common mode of transmission is person-to-person spread during close contact with an infectious case. This includes transmission in poor hygiene conditions, transmission between young children, and transmission during certain types of sexual activity (such as oral-anal sex). Person-to-person transmission is common due to the low infectious dose. Outbreaks can occur in conditions of crowding and poor sanitation and hygiene. Rarely infections may be foodborne, caused by infectious food handlers contaminating ready-to-eat food during preparation and handling. Many of the notifications reported in Australia represent infections that have been acquired during overseas travel. Populations at the highest risk of acquiring shigellosis within Australia include Aboriginal and/or Torres Strait Islander communities and MSM.[50,51]

Surveillance data includes confirmed and probable cases. A confirmed case requires laboratory definitive evidence of *Shigella*.[xxi] Since 2014, when PCR testing was introduced, jurisdictions have classified PCR positive cases differently. In the first half of 2018, Victoria, the Northern Territory and Tasmania continued to include cases found to be positive on PCR alone as confirmed cases in their surveillance data, whereas only cases confirmed by culture were included in the Australian Capital Territory, New South Wales, Queensland, South Australia and Western Australia surveillance data. On 1 July 2018, the national shigellosis case definition was changed to include 'probable cases.' Probable cases include those with a detection of *Shigella* on nucleic acid testing only (PCR).[xxii]

Overall trend

- The notification rate remained steady between 2001 (when national notification began) and 2013, except for peaks in the number of notifications in 2005 and 2008 (observed in multiple jurisdictions).
- From 2014 onwards, a marked increase in notifications was observed. This is due, at least in part, to the increase in PCR testing as a method of laboratory diagnosis.
- In 2018, there was a 40% increase in the number of shigellosis notifications compared to 2017. This is largely due to inclusion of a probable shigellosis case definition in the national surveillance case definition which was introduced on 1 July 2018.
- An ongoing outbreak of *Shigella flexneri* 2b across multiple jurisdictions has contributed to the increase of cases observed in 2017 and 2018.[4]
- In New South Wales, outbreaks amongst MSM contributed to the increases observed in 2014 and 2016 (refer to the New South Wales OzFoodNet 2016 annual report).[52]

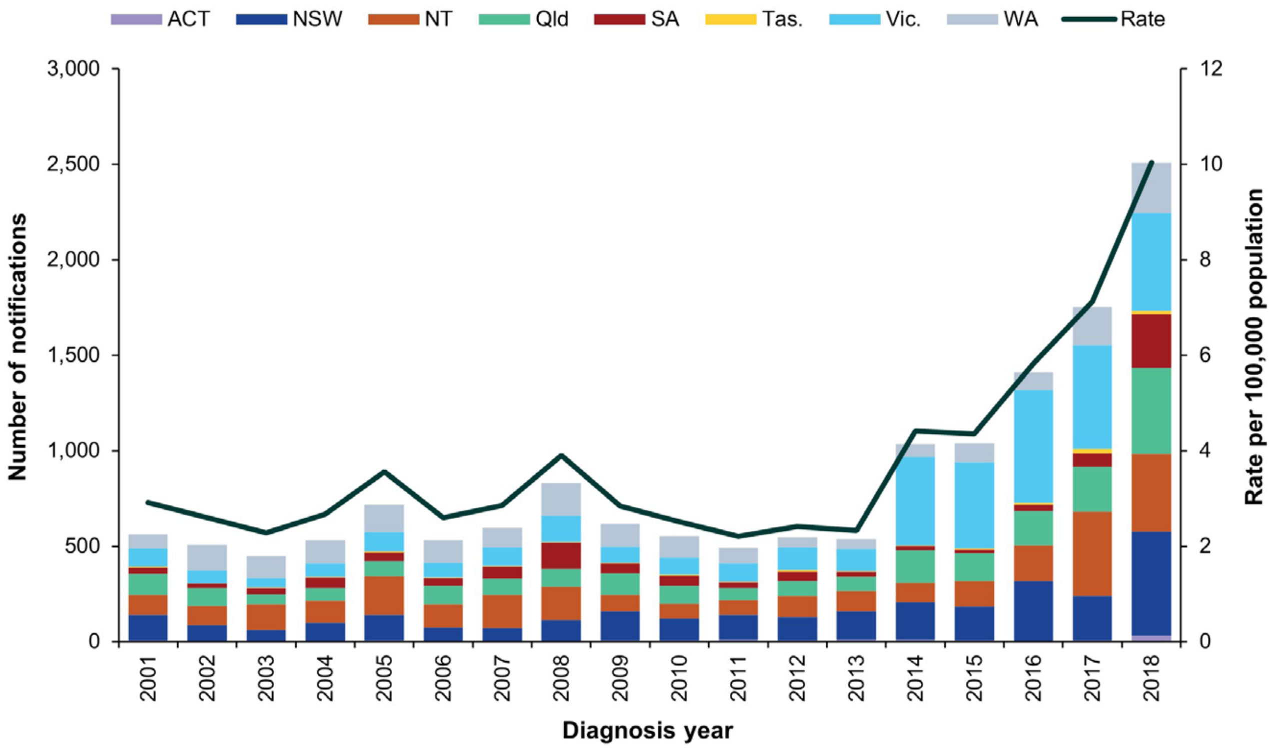
Previous outbreaks in Australia

In addition to non-foodborne outbreaks amongst MSM and Aboriginal and/or Torres Strait Islander communities, nine foodborne outbreaks have been reported in Australia since 2000. The most significant foodborne outbreak was associated with the consumption of imported baby corn, with 55 cases reported in Australia in 2007.[53]

xxi Shigellosis case definition: https://www.health.gov.au/resources/publications/shigellosis-surveillance-case-definition.

xxii The *ipaH* gene used as the target for all current nucleic acid tests for *Shigella* is common to Shigella species and to enteroinvasive *Escherichia coli* (EIEC).

Figure 16: Shigellosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2018[a]



a The national shigellosis case definition changed on 1 July 2018 to include 'probable' cases.

Epidemiology of shigellosis in Australia, 2018

Table 18: Summary of shigellosis notifications in Australia, 2018

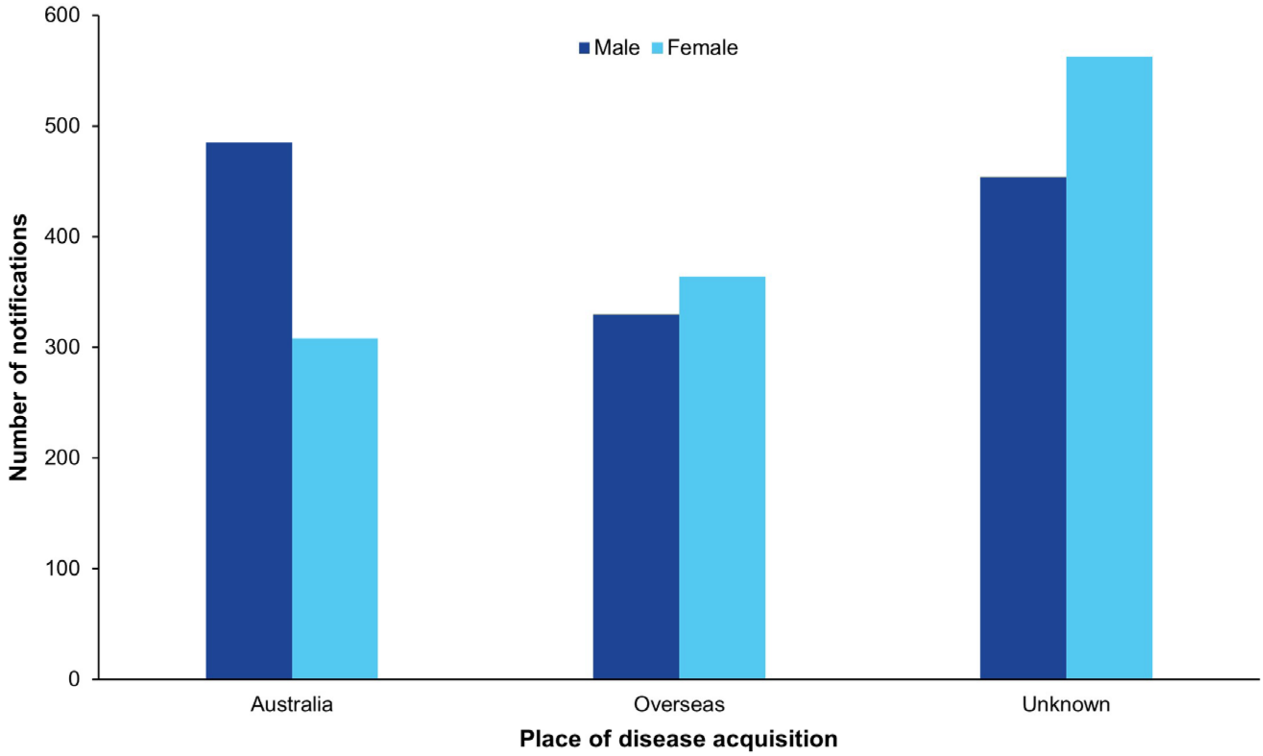
Category	Value
Number of notifications	2,508
Rate per 100,000 population	10 cases
Jurisdiction with the highest number of notifications	Victoria (n = 512; 20%)
Foodborne outbreaks	0

- The majority of cases reported in 2018 were males (n = 1,269; 51%) compared with females (n = 1,234; 49%). The median age of cases was 31 years of age (range 0–95 years), and the most affected age group were those aged 0–4 years (n = 420; 17%).
- The greatest number of cases was in Victoria (n = 512), but the highest notification rate was in the Northern Territory (164 cases per 100,000 population).
- Probable cases accounted for more than half of the total cases reported between July and December 2018 (n = 895; 58%).
- The most common species reported among confirmed cases with typing data available was *S. flexneri* (n = 711; 54%), followed by *S. sonnei* (n = 590; 45%). The remaining isolates were *S. boydii* and *S. dysenteriae*, accounting for one percent of cases.
- Antimicrobial susceptibility testing is often undertaken on culture positive cases. Of cases that were tested, a number of multi-drug resistant *Shigella* cases were reported in Queensland (n = 42 cases, comprising n = 40 *Shigella sonnei* biotype a and n = 2 *Shigella flexneri*); New South Wales (n = 25 cases of *Shigella sonnei* biotype g); South Australia (n = 5 cases of *Shigella sonnei* biotype g); and Victoria (n = 195 isolates).

Country of acquisition

- Information on the country of acquisition was available for 59% of cases (n = 1,491/2,508), of which more than half (n = 795/1,491; 53%) were reported as acquired in Australia.
- Females accounted for a higher proportion of overseas-acquired cases (n = 364; 52%), in contrast to Australian-acquired cases where most cases were males (n = 485; 61%) (Figure 18).
- Consistent with previous years, overseas-acquired cases (n = 696) were most commonly acquired in India (n = 158; 23%) and Indonesia (n = 139; 20%).
- Of the 1,017 cases with unknown country of acquisition, 44% (n = 447) were probable cases.

Figure 17: Shigellosis (confirmed and probable) notifications in Australia by place of acquisition and sex,[a] 2018



a Cases with unknown sex (n = 4) were excluded.

Aboriginal and/or Torres Strait Islander people (n = 766)

- Indigenous status data was available for 87% of cases (n = 2,179), with 35% of cases identifying as Aboriginal and/or Torres Strait Islander (n = 766/2,179).
- The largest number of cases among Aboriginal and/or Torres Strait Islander people occurred in the Northern Territory (n = 374; 49%), followed by South Australia (n = 162; 21%) and Western Australia (n = 129; 17%) (Table 19).
- With the exception of Victoria, Tasmania and the Australian Capital Territory, in all other jurisdictions the number of notifications in Aboriginal and/or Torres Strait Islander peoples was higher in 2018 than the five-year historical mean.
- A higher burden of disease has been consistently observed amongst Aboriginal and/or Torres Strait Islander people between 2013 and 2018 (Figure 19).
- The rate of shigellosis in Indigenous peoples in 2018 (114 cases per 100,000 population) was ten times as high as the overall national rate of shigellosis (10 cases per 100,000 population).

- The majority of the 542 isolates from Aboriginal and/or Torres Strait Islander people that were speciated were identified as *S. flexneri* (n = 483; 89%), with the remainder *S. sonnei* (n = 59; 11%). Where known, most *S. flexneri* cases from Aboriginal and/or Torres Strait Islander people were serotype 2b (n = 423; 87%) and almost all *S. sonnei* cases were biotype a (n = 53; 89%).
- Of the cases reported in Aboriginal and Torres Strait Islander people, 19% (n = 144) were probable cases.
- Conversely, the majority of the 782 isolates from non-Indigenous people that were speciated were identified as *S. sonnei* (n = 531; 68%), with the remainder *S. flexneri* (n = 228; 29%), *S. boydii* (n = 15; 2%) and *S. dysenteriae* (n = 8; 1%). Where known, the majority of non-Indigenous *S. sonnei* cases were biotype g (n = 438; 82%) and the highest proportion of non-Indigenous *S. flexneri cases* were serotype 2a (n = 88; 39%).

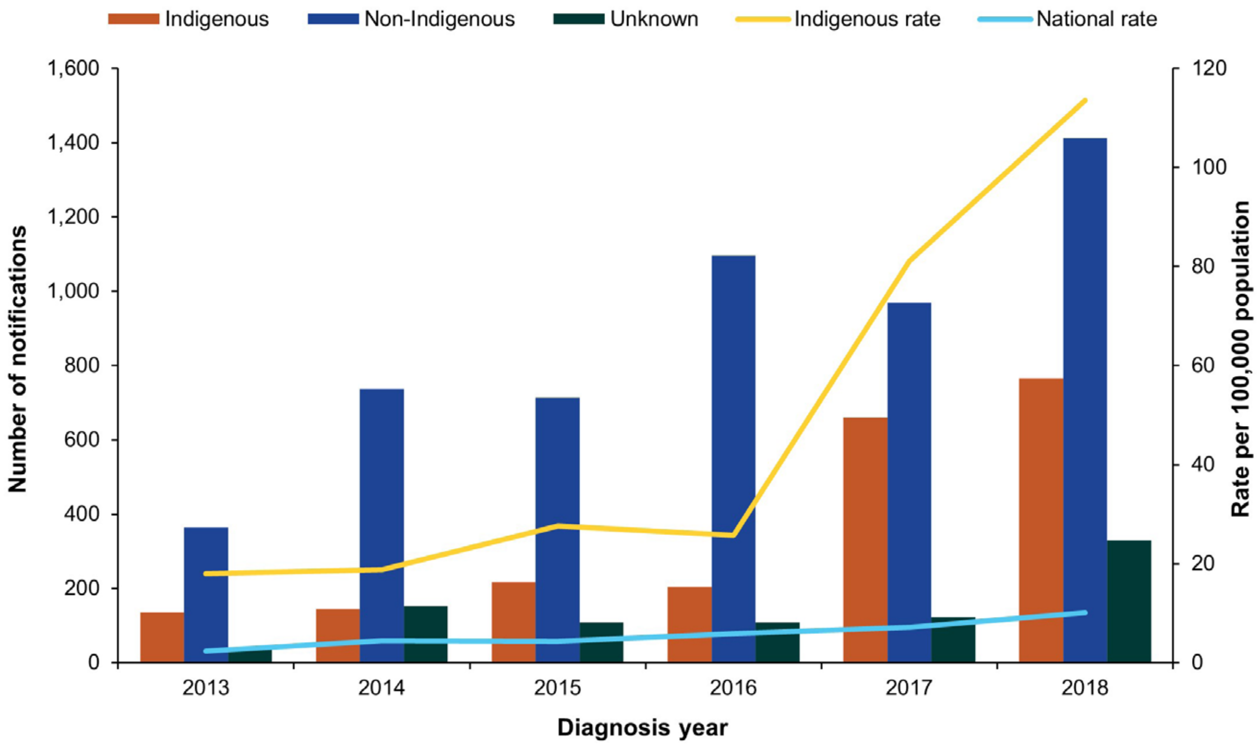
Table 19: Shigellosis (confirmed and probable) notifications in Aboriginal and/or Torres Strait Islander people in Australia by place of residence, 2018[a]

Jurisdiction[b]	2018 notifications	2018 rate per 100,000 people[a]	Mean notifications 2013–2017	% change in notifications (2018 compared to 2013–2017)
ACT	0	0	0	0%
NSW	10	5.1	4	150%
NT	374	477	163	129%
Qld	88	44	45	96%
SA	162	450	11	1373%
Tas.	0	0	0	0%
Vic.	3	6.7	4	-25%
WA	129	146	45	187%
Total	**766**	**114**	**272**	**182%**

a Rates are calculated using population estimates of Aboriginal and Torres Strait Islander Australians as at 30 June 2018.

b ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

Figure 18: Shigellosis (confirmed and probable)[a] notifications and rates per 100,000 population in Australia by Indigenous status, 2013–2018[b]



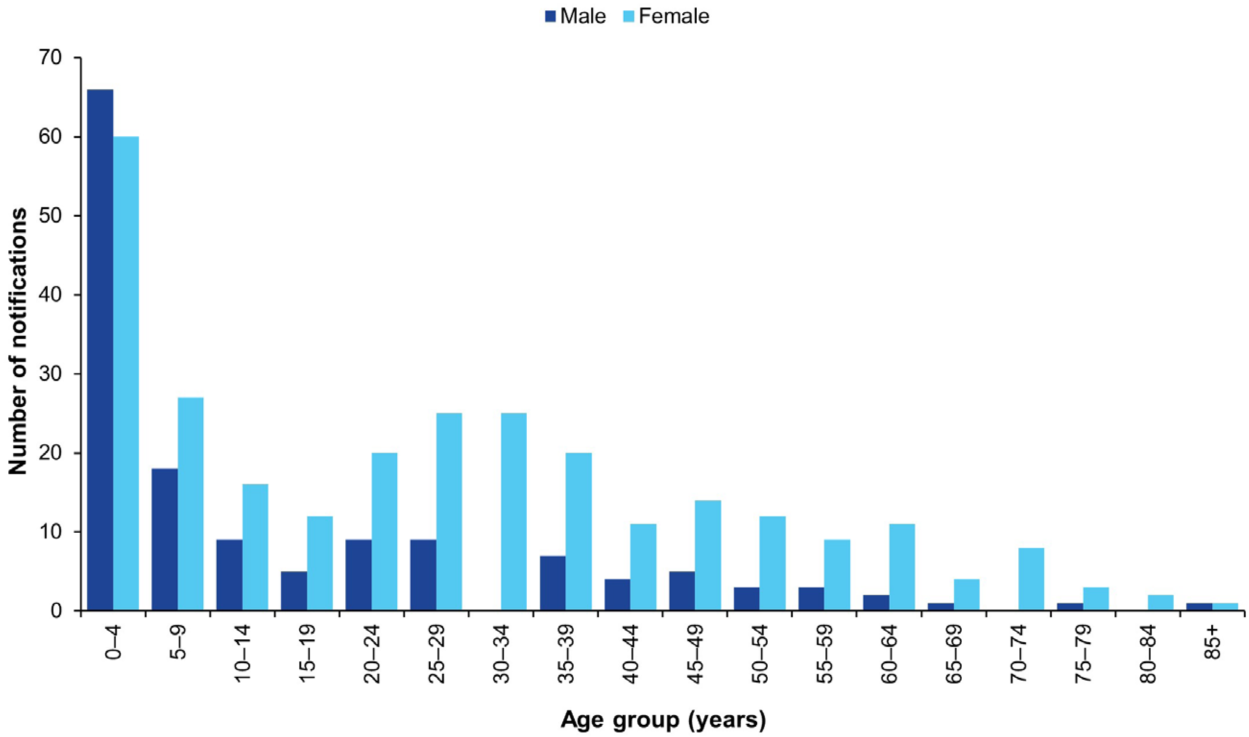
a On 1 July 2018, the national shigellosis case definition was changed to include 'probable cases'; therefore, probable cases are included from 2018 onwards.

b Cases with unknown Indigenous status were included as non-Indigenous in the rate calculations.

Shigella flexneri serotype 2b outbreak amongst Aboriginal and/or Torres Strait Islander people

- In 2017 and 2018 there was an outbreak of *S. flexneri* 2b among Aboriginal and/or Torres Strait Islander people in Australia. Cases of *S. flexneri* 2b were first identified in remote areas of the Northern Territory in late 2016. A total of 350 *S. flexneri* 2b cases were notified in 2017 across the Northern Territory, South Australia, Western Australia and Queensland. Of these cases, the majority were reported in Aboriginal and Torres Strait Islander people (n = 336).[4] The outbreak continued into 2018.
- There were a total of 450 *S. flexneri* 2b cases reported in Australia in 2018, of which 94% (n = 423) were reported in Aboriginal and Torres Strait Islander people across the Northern Territory (n = 202), Western Australia (n = 118), Queensland (n = 30), South Australia (n = 72) and Victoria (n = 1).
- The highest number of cases of *S. flexneri* 2b were reported in January 2018 and declined throughout the year.
- Among the cases reported as Aboriginal and Torres Strait Islander peoples, most were females and aged between 0 and 4 years (Figure 19).
- A variety of public health actions were undertaken in outbreak affected areas, including improved contact tracing and specimen collection from symptomatic cases and increased health promotion and awareness campaigns in remote communities.
- The Northern Territory outbreak in 2017 is further described in the Northern Territory surveillance report;[54] and cases in Queensland are further described in an outbreak investigation report.[50] The outbreak continued into 2019.

Figure 19: *Shigella flexneri* serotype 2b confirmed and probable notifications in Aboriginal and/or Torres Strait Islander people in Australia, by age group and sex, 2018



Shiga toxin-producing *Escherichia coli* infection and haemolytic uraemic syndrome

Shiga toxigenic *E. coli* (STEC) infection is a diarrhoeal illness caused by the strains of the *Escherichia coli (E. coli)* bacterium that produce shiga toxins. The principal reservoirs of STEC in Australia are the lower intestinal tract of ruminants, particularly cattle and sheep. Infections in humans can occur after consuming contaminated food including undercooked meat, particularly minced beef/burgers, unwashed salad and vegetables and unpasteurised milk or milk products, drinking or swimming in contaminated water, close contact with an infectious case or direct contact with infectious animals on farms or at petting zoos.[44]

Haemolytic uraemic syndrome (HUS) is a severe and potentially fatal condition characterised by kidney failure, bleeding and anaemia, and is more common in young children and the elderly. While STEC is the most common infectious agent that causes HUS, it can also be caused by other infectious agents including *Shigella* and *Streptococcus pneumoniae*. HUS can also result from non-infectious causes. Cases resulting from a STEC infection usually report a history of a diarrhoeal illness, often bloody, up to three weeks (usually within seven days) prior to the onset of HUS. Attempts are made for collection and microbiological examination of stool samples from all HUS cases. However, due to the timing since onset of diarrhoea, STEC may no longer be detectable in the stool at the time of subsequent stool testing.

Surveillance data of STEC and HUS consists of confirmed cases only. A confirmed case of STEC requires laboratory definitive evidence,[xxiii] and a confirmed case of HUS requires clinical evidence only.[xxiv] Where STEC is isolated in the context of HUS, it is notified as both STEC and HUS.[xxv]

Prior to 1 July 2016, the case definition required 'identification of the gene associated with the production of shiga toxin or vero toxin in *E. coli* by nucleic acid testing on isolate or raw bloody diarrhoea'. The case definition was revised in light of the increasing uptake of CIDT to make provision for the detection of stx_1 and/or stx_2 genes in faeces without macroscopic evidence of blood or diarrhoea.

Overall trend

Notification rates of STEC have trended upwards between 2001 (when national notification began) and 2015. The peak in 2013 was related to a zoonotic outbreak in Queensland (see below) (Figure 20).

From 2016 onwards there has been a marked increase in the number of STEC cases notified, in line with the change to the national surveillance case definition.

Notification rates for STEC are significantly influenced by local testing practices.

- The consistently higher rates observed in South Australia since 2001 reflect the routine testing of all bloody stool samples in addition to clinician requests.
- In June 2016, the only laboratory in South Australia conducting STEC testing began testing all faeces for STEC, instead of only bloody stool samples, resulting in an increase in notifications.

HUS is rare in Australia, with notification rates relatively stable since 1999 when it became nationally notifiable. The number of notifications reported in 2018 (n = 13) is lower than the five-year historical mean of 17 cases per year (Figure 22).

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xxiii Shiga toxin-producing *Escherichia coli* (STEC) case definition: https://www.health.gov.au/resources/publications/shiga-toxin-producing-escherichia-coli-stec-infection-surveillance-case-definition.

xxiv Haemolytic uraemic syndrome (HUS) case definition: https://www.health.gov.au/resources/publications/haemolytic-uraemic-syndrome-hus-surveillance-case-definition.

xxv Note that the usual practice in Victoria is to notify HUS cases with STEC infection as HUS only. For consistency, Victorian HUS cases diagnosed with a STEC infection have been included in the STEC data presented here.

Previous outbreaks in Australia

Most STEC cases in Australia are sporadic, though outbreaks have been reported. Risk factors identified in a national case-control study in Australia between 2003 and 2007 included consuming hamburgers; eating at restaurants; occupational exposure to animals or raw red meat by case or household member; antibiotic use in the four weeks before illness; consumption of sliced chicken meat or corned beef from a delicatessen; bush camping in Australia; and eating at catered events.[55]

Foodborne outbreaks

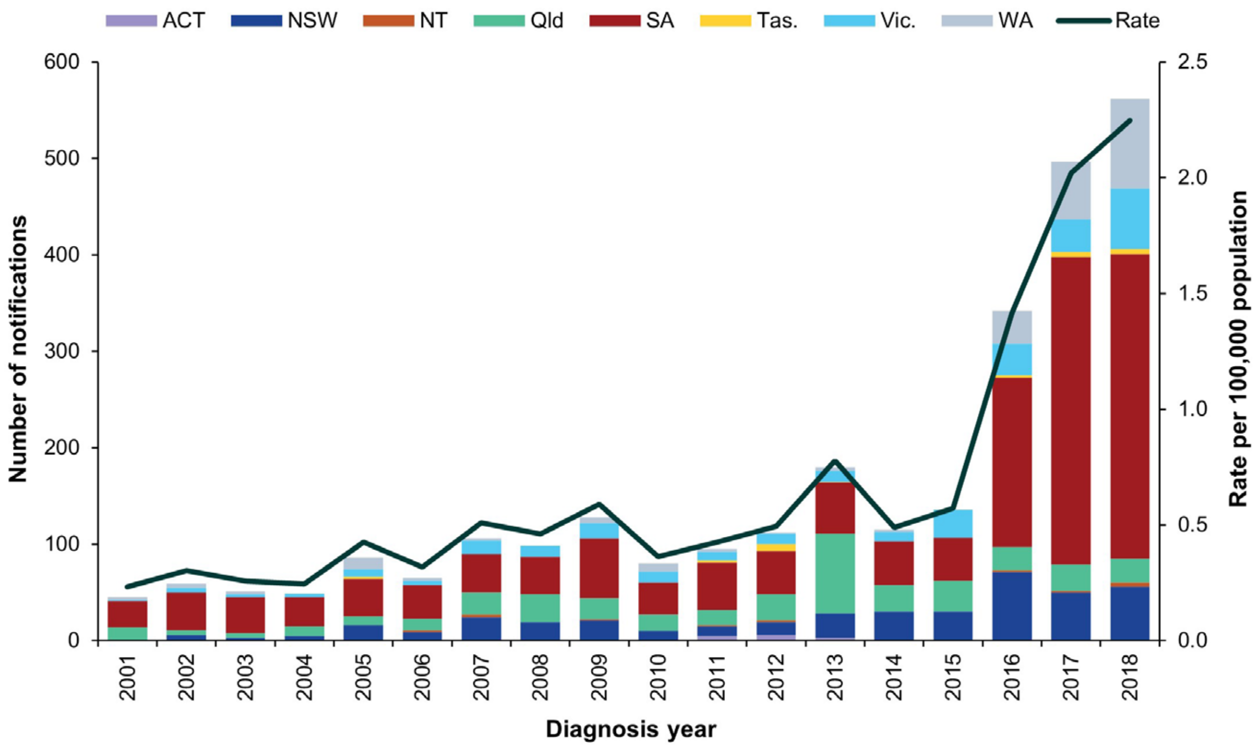
Significant foodborne outbreaks have been reported internationally and have most commonly been associated with ground beef or sprouts. Sprouts from a farm in Germany were the implicated source of an international outbreak in 2011 that included over 3,000 STEC cases and 800 HUS cases.[56] In Australia, foodborne outbreaks are rare, the most notable being a large outbreak of *E. coli* O111 infection in 1995 associated with the consumption of contaminated mettwurst.[46] Since 2000, implicated foods in confirmed and probable foodborne STEC outbreaks reported in Australia include:

- potato salad consumed at a camp in rural South Australia in 2009 (n = 31, no HUS cases);[57] and
- kangaroo meat consumed in a remote Northern Territory community in 2012 (n = 5, no HUS cases).[58]

Non-foodborne outbreaks

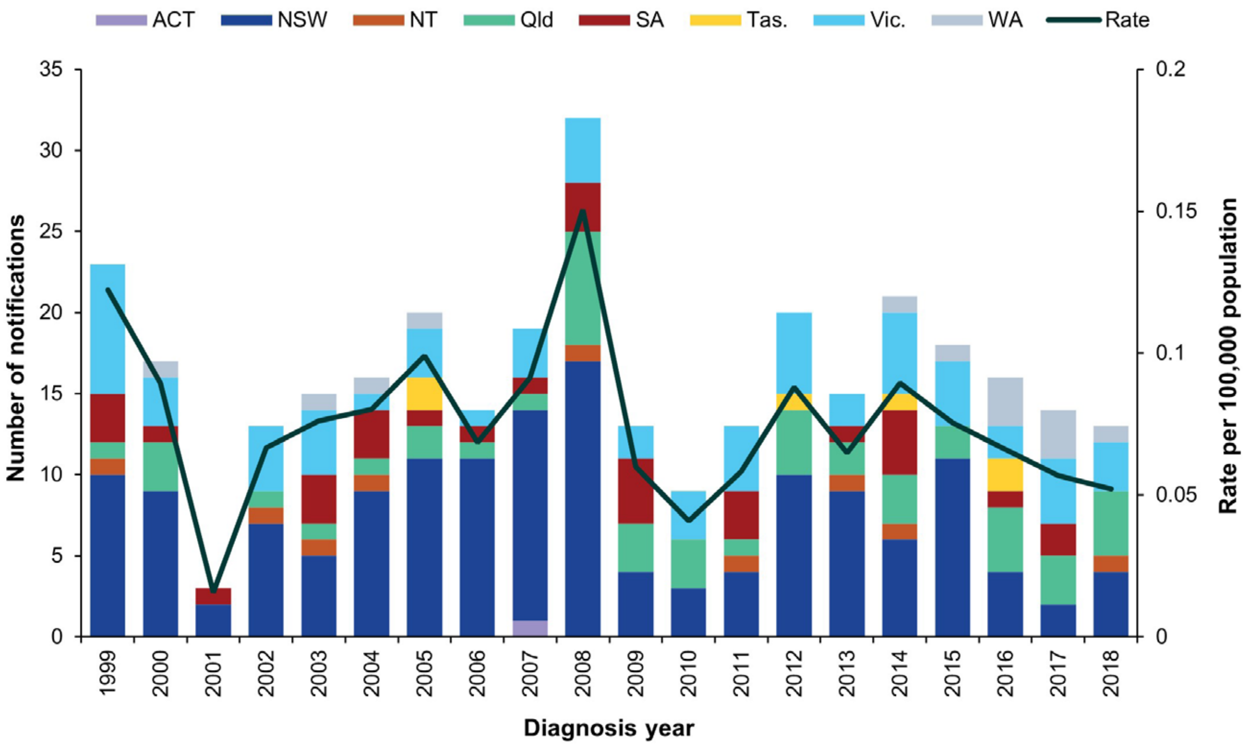
Outbreaks due to contaminated tank water, person-to-person transmission and zoonotic transmission at petting zoos have been reported in Australia. The largest STEC outbreak in Australia occurred following contact with animals at a petting zoo in Queensland in 2013 (n = 57 STEC cases, no HUS cases).[59]

Figure 20: STEC notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2018[a]



a Data includes HUS cases where a STEC organism was isolated (see footnote xxv).

Figure 21: HUS notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1999–2018



Epidemiology of STEC and HUS in Australia, 2018

Table 20: Summary of STEC and HUS notifications in Australia, 2018

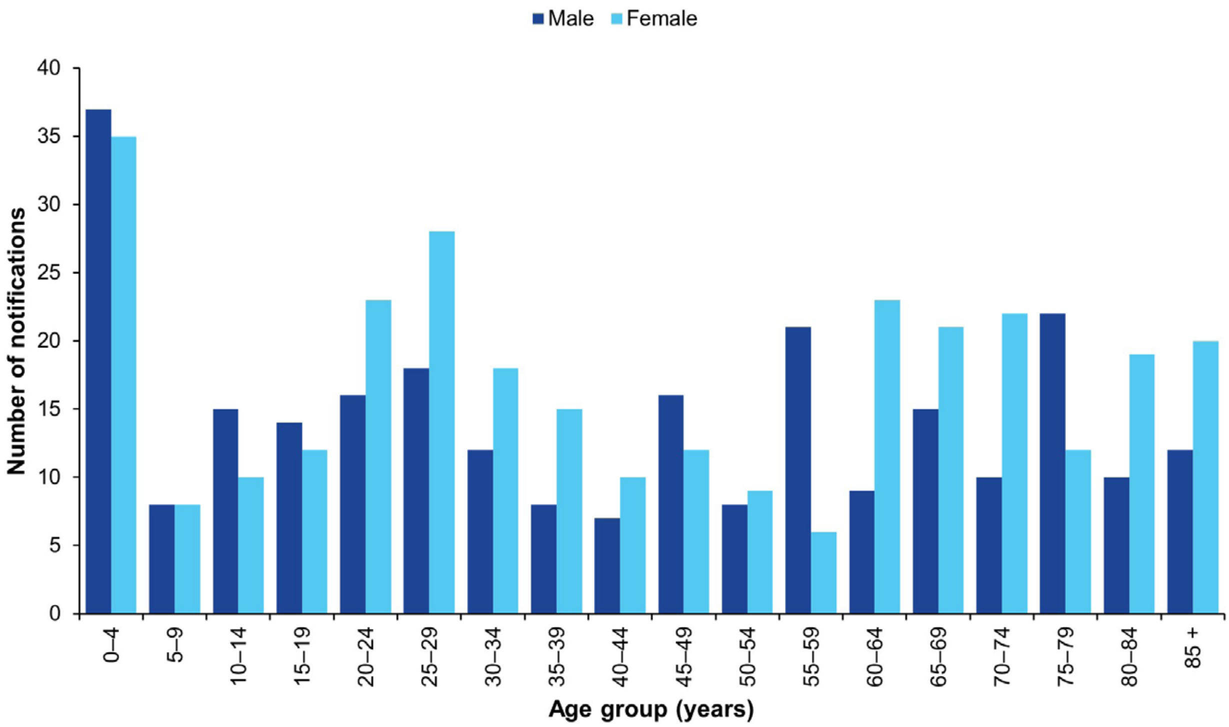
Category	STEC	HUS
Number of notifications	562	13
Rate per 100,000 population	2.2 cases	0.1 cases
Jurisdiction with highest number of notifications	South Australia (n = 316; 56%)	New South Wales (n = 4; 31%) and Queensland (n = 4; 31%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	29	1
Foodborne outbreaks	0	0

a Indigenous status was not known for 11 STEC cases.

STEC

- Notifications were highest in children aged 0–4 years (n = 72; 13%), followed by those aged 25–29 years (n = 45; 8%). The median age of all cases was 41 years of age (range 0–101 years).
- STEC cases were more common in females (n = 303; 54%) than in males (n = 258; 46%). However, cases in males were more commonly reported in the 0–4, 55–59 and 75–79 years age groups (Figure 23).
- Where known, the majority of cases (n = 338/427; 79%) were acquired in Australia. Of the cases that were known to be acquired overseas (n = 89), Indonesia was the most commonly reported country of acquisition (n = 34), accounting for 38% of all overseas-acquired cases.

Figure 22: STEC cases in Australia by age group and sex, 2018[a]



a Excludes cases with unknown sex (n = 1).

HUS

- Consistent with previous years, HUS was most commonly reported in children aged less than five years (n = 4; 31%). Cases had a median age of 44 years of age (range 0–86 years).
- Notifications were more common in males (n = 7; 54%) than in females (n = 6; 46%).
- In accordance with recent years, STEC infection was identified in 85% of the HUS cases reported in 2018 (n = 11/13). Of the remaining two cases, one was due to *Streptococcus pneumoniae* and the other was due to invasive group A streptococcus.

Outbreaks of gastrointestinal disease including foodborne disease outbreaks

In 2018, a total of 137 outbreaks of gastrointestinal illness caused by foodborne, animal-to-person, environmental or waterborne disease were reported by OzFoodNet sites, affecting 1,768 individuals. The majority of outbreaks (n = 127/137; 93%) were a result of foodborne and probable foodborne transmission of infection (Table 21).

Table 21: Gastrointestinal disease outbreaks and ill people by transmission mode in Australia, 2018

Transmission mode	Outbreaks			Ill people		
	Number, 2018	Proportion	Annual mean 2013–2017	Number, 2018	Proportion	Annual mean 2013–2017
Foodborne and probable foodborne	127	93%	162	1,644	93%	2,626
Environmental and probable environmental	9	7%	16	106	6%	122
Animal-to-person and probable animal-to-person	0	0%	2	0	0%	20
Waterborne and probable waterborne	1	1%	2	18	1%	5
Total	**137**	**100%[a]**	**182**	**1,768**	**100%**	**2,773**

a Does not equal 100% due to rounding.

Foodborne and probable foodborne outbreaks

OzFoodNet sites reported 127 outbreaks where the consumption of food was the probable or confirmed mode of transmission (hereon referred to collectively as foodborne outbreaks). Foodborne outbreaks in 2018 affected a total of 1,644 people. The total number of outbreaks and the number of affected people reported in 2018 were both lower than the respective five-year historical means (n = 162 outbreaks and n = 2,626 ill people) (Table 21). Admission to hospital was required for at least 283 people across Australia, and 13 deaths were reported during the outbreaks (Table 22).

Western Australia and New South Wales reported the highest numbers of foodborne outbreaks in 2018 (Table 22), reporting 37 and 33 outbreaks respectively. New South Wales reported the highest number of ill people overall in 2018 (n = 610); however, Tasmania reported the highest average number of ill people per outbreak (n = 21). Consistent with previous years, outbreaks more commonly occurred in the warmer months of January to March (Quarter 1) (Figure 23 and Figure 24).

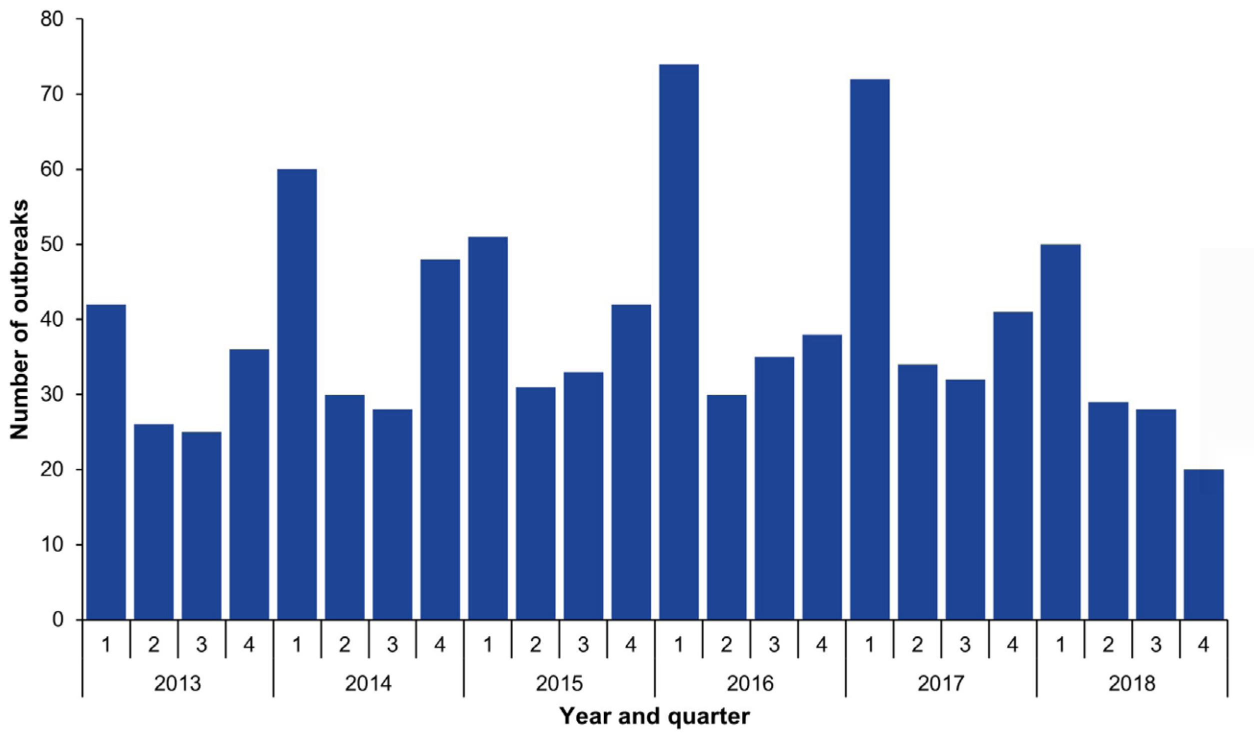
A summary of the foodborne outbreaks is provided in the following section. Refer to Appendix B for details on individual outbreaks.

Table 22: Foodborne outbreaks and affected people in Australia by jurisdiction, 2018

Jurisdiction[a]	Outbreaks		Ill people			
	Number of outbreaks	Proportion	Total number	Mean number ill per outbreak	Hospitalised	Fatalities
MJOI	2	2%	55	28	50	8
ACT	4	3%	34	9	6	0
NSW	33	26%	610	18	79	5
NT	6	5%	77	13	7	0
Qld	13	10%	95	7	9	0
SA	11	9%	131	12	30	0
Tas.	3	2%	64	21	12	0
Vic.	18	14%	235	13	33	0
WA	37	29%	343	9	57	0
Total	**127**	**100%**	**1,644**	**130**	**283**	**13**

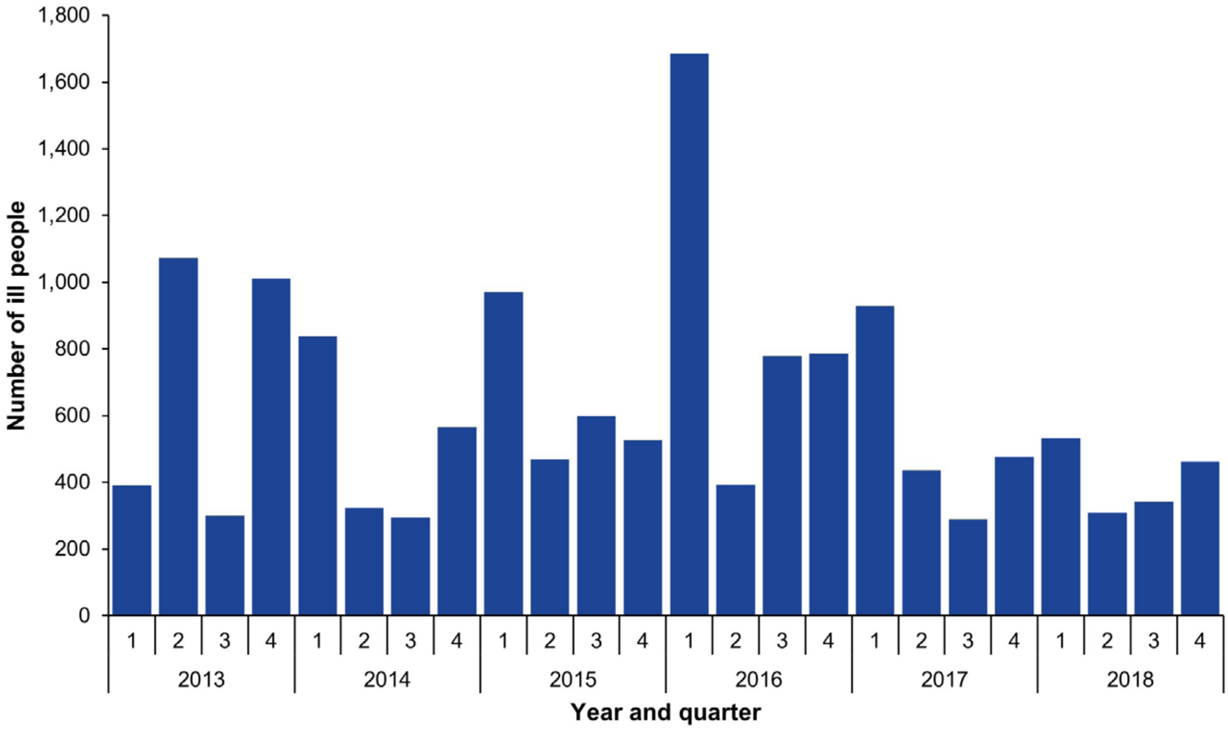
a MJOI: multi-jurisdictional outbreak investigation; ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

Figure 23: Foodborne outbreaks in Australia by year and quarter,[a] 2013–2018



a Year and quarter of the outbreak is based on the month of onset of the first case or the month of notification of the first case or the month in which the outbreak investigation commenced.

Figure 24: Number of ill people in foodborne outbreaks in Australia by year and quarter,[a] 2013–2018



a Year and quarter of the outbreak is based on the month of onset of the first case or the month of notification of the first case or the month in which the outbreak investigation commenced.

Aetiologies

Consistent with previous years, *Salmonella* was the most commonly identified foodborne pathogen, responsible for 56% of all outbreaks (n = 71/127) and 61% of all cases of foodborne illness (n = 1,007/1,644) reported during outbreaks in 2018 (Table 23). The most commonly identified serotype, accounting for 86% (61/71) of all *Salmonella* outbreaks reported in 2018, was *S*. Typhimurium, of which 38 different causative MLVA profiles were identified.

Table 23: Foodborne outbreaks, ill people and hospitalisations in Australia by aetiology, 2018

	Outbreaks		Ill people		Hospitalisations	
Aetiological agent	n	% of all outbreaks	n	% of all ill	n	% of all hospitalised
Salmonella	71	56%	1,007	61%	206	73%
Norovirus	5	4%	128	8%	1	< 1%
Scombrotoxin	5	4%	23	1%	7	3%
Ciguatoxin	4	3%	13	1%	0	0%
Campylobacter	4	3%	17	1%	0	0%
Clostridium perfringens	2	2%	25	2%	2	1%
Listeria monocytogenes	2	2%	27	2%	27	10%
Hepatitis A	1	< 1%	31	2%	26	9%
Bacillus cereus	1	< 1%	15	1%	0	0%
Unknown	32	25%	358	22%	14	5%
Total	**127**	**100%**	**1,644**	**100%**	**283**	**100%**

Food commodity

A food vehicle was identified in almost half of all foodborne outbreaks in 2018 (n = 61/127; 48%). Outbreaks were categorised as being attributable to selected broad food categories if a single contaminated ingredient was identified, or if all the identified ingredients belonged to a single food category. A single food commodity was identified for 69% of foodborne outbreaks (n = 87/127) in 2018. The most commonly identified commodity was eggs (n = 26; 20%), followed by meat (n = 9; 7%) and seafood (n = 9; 7%) (Table 24). In 2018, for some aetiological agents, one food commodity was found to be responsible for a large proportion of outbreaks: for example, 37% of all *Salmonella* outbreaks (26/71) were attributed to eggs (Table 25).

Table 24: Foodborne outbreaks and ill people in Australia by food commodity, 2018 (n = 127)

Category	Outbreaks		Ill people	
	n	%	n	%
Dairy	1	< 1%	5	< 1%
Eggs[a]	26	20%	535	33%
Meat	9	7%	113	7%
Produce	4	3%	113	7%
Seafood	9	7%	36	2%
Mixed/multiple	19	15%	229	14%
Not attributed	59	46%	613	37%
Total	**127**	**100%**	**1,644**	**100%**

a Including: raw; lightly cooked; or used as a binding agent.

Table 25: Number of foodborne outbreaks in Australia by aetiology and food commodity, 2018 (n = 127)

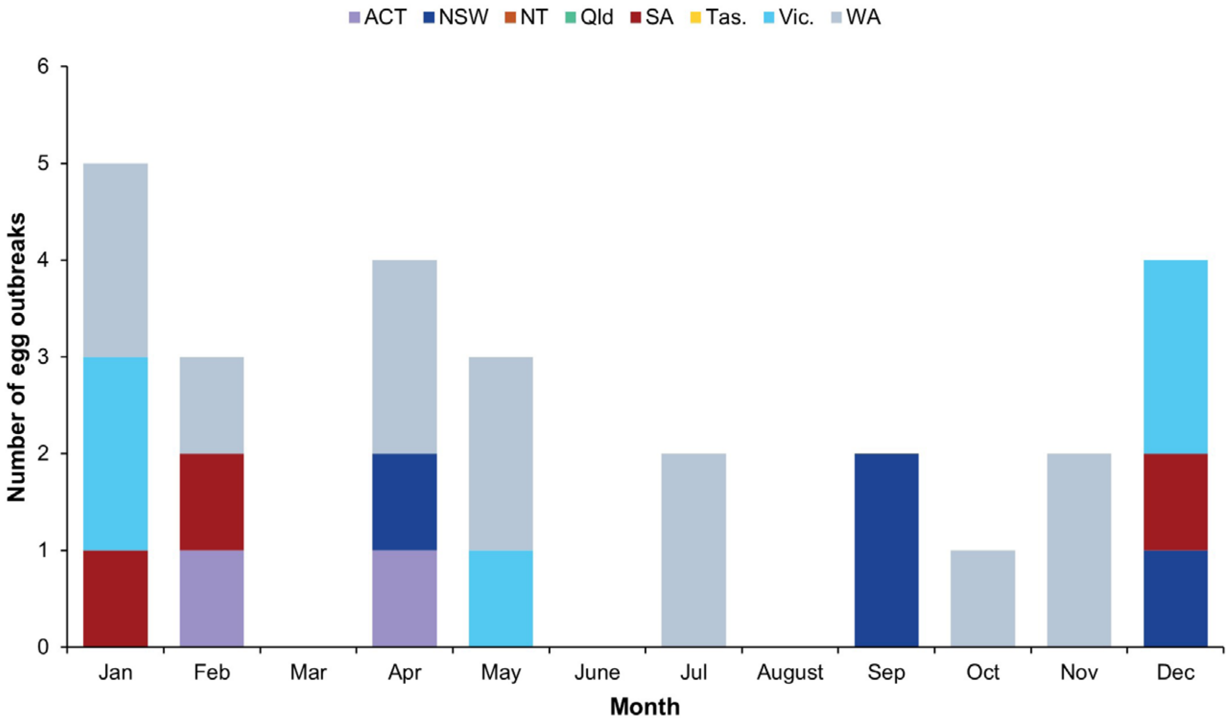
Aetiology	Dairy	Eggs[a]	Meat	Produce	Seafood	Mixed/ multiple	Not attributed
Bacillus cereus	0	0	1	0	0	0	0
Campylobacter	1	0	1	0	0	1	1
Ciguatoxin	0	0	0	0	4	0	0
Clostridium perfringens	0	0	1	0	0	0	1
Hepatitis A	0	0	0	1	0	0	0
Listeria monocytogenes	0	0	0	1	0	0	1
Norovirus	0	0	0	0	0	1	4
Salmonella	0	26	3	2	0	12	28
Scombrotoxin	0	0	0	0	5	0	0
Unknown	0	0	3	0	0	5	24
Total	**1**	**26**	**9**	**4**	**9**	**19**	**59**

a Including: raw; lightly cooked; or used as a binding agent.

Eggs

Outbreaks of salmonellosis associated with the consumption of raw or minimally cooked egg products are an important cause of foodborne outbreaks in Australia.[37,60] Eggs were identified as the probable or confirmed source for 26 foodborne outbreaks reported in 2018 (20% of all outbreaks). Egg-related outbreaks occurred in five jurisdictions in 2018 (12 in Western Australia, five in Victoria, four in New South Wales, three in South Australia, and two in the Australian Capital Territory). Egg-associated outbreaks peaked in January (n = 5) (Figure 26). Egg-associated outbreaks affected 535 people, of whom 122 were admitted to hospital. *Salmonella* was identified as the aetiological agent for all of the egg-associated outbreaks (n = 26; 100%). These outbreaks comprised 24 *S*. Typhimurium outbreaks (92%) with 18 different MLVA profiles identified, and one outbreak each of *S*. Virchow and *S*. Infantis. The setting of preparation was most commonly restaurants or cafés (n = 16; 62%), followed by a private residence (n = 4; 15%). The most commonly implicated foods in egg-associated outbreaks were sauces or dressings made with raw eggs (n = 11; 42%) and desserts containing raw eggs (n = 7; 27%). See Appendix B for further details.

Figure 25: Egg outbreaks by month and jurisdiction, Australia, 2018 (n = 26)



Seafood

Seafood (comprising the three commodities of fish, molluscs and crustaceans) was implicated as the source in nine foodborne outbreaks reported in 2018. The aetiological agents identified were scombrotoxin (n = 5) and ciguatoxin (n = 4).

Scombrotoxin outbreaks occur when certain types of fish that contain high levels of histamine are eaten. There were five scombrotoxin outbreaks in 2018, all of which occurred in the summer and autumn (n= 3 and n = 2, in February and March respectively). The outbreaks occurred in New South Wales (n = 3), Victoria (n = 1) and Queensland (n = 1). Three outbreaks were due to consumption of contaminated fish purchased at fish markets; one outbreak was due to consumption of fish at a restaurant (assumed to be a non-recreational catch); and one outbreak was due to the consumption of fish caught during recreational fishing.

Ciguatoxin outbreaks occur when certain types of reef fish that live in warm tropical waters are eaten. The ciguatoxin cannot be removed by cleaning or cooking the fish; ingestion of ciguatoxin can only be prevented by not eating the fish. There were four ciguatoxin outbreaks in 2018 occurring in Queensland (n = 3) and New South Wales (n = 1) in summer and autumn. Two outbreaks were due to consumption of fish caught by recreational fishing and the other two were due to consumption of contaminated fish purchased at fish markets or vendors.

Meat

Meat was implicated as the source of nine foodborne outbreaks reported in 2018. Meat-related outbreaks occurred in five jurisdictions in 2018 (three in the Northern Territory, three in Victoria, one in Queensland, one in Tasmania and one in the Australian Capital Territory). There was no seasonal pattern observed with these outbreaks, with three outbreaks each occurring in spring and summer months, two in autumn, and one in winter.

Poultry (n = 6) was the most commonly reported type of meat implicated in meat-related foodborne outbreaks in 2018. *Salmonella* Typhimurium was the identified pathogen in three poultry outbreaks; the other outbreaks featured *Clostridium perfringens* (n = 1), *Bacillus cereus* (n = 1) and *Campylobacter* (n = 1).

Four meat-related outbreaks were associated with consumption of meat prepared in a restaurant/café or take-away venue.

Settings

Restaurants/cafés comprised the most commonly reported food preparation setting, accounting for just under half of all foodborne outbreaks (n = 61; 48%); this was also the food preparation setting with the largest total number of ill people reported during outbreaks in 2018 (n = 610; 37%) (Table 26).

Table 26: Foodborne outbreaks in Australia by setting prepared, 2018 (n = 127)

Setting prepared	Outbreaks		Ill people		Hospitalisations	
	n	% of all outbreaks	n	% of all ill people	n	% of all hospitalisations
Restaurant/café	61	48%	610	37%	70	25%
Private residence	16	13%	127	8%	34	12%
Primary production	11	9%	388	24%	116	41%
Take-away	9	7%	67	4%	11	4%
Aged care	8	6%	73	4%	6	2%
Commercial caterer	6	5%	120	7%	5	2%
Correctional facility	4	3%	61	4%	3	1%
Fair/festival/ mobile service	2	2%	6	< 1%	0	—
Mining camp	2	2%	7	< 1%	1	< 1%
National franchised fast food	2	2%	69	4%	5	2%
Camp	1	< 1%	31	2%	4	1%
Child care	1	< 1%	15	1%	0	—
Imported food	1	< 1%	31	2%	26	9%
Private caterer	1	< 1%	5	< 1%	0	—
Student accommodation	1	< 1%	13	1%	2	< 1%
Unknown	1	< 1%	21	1%	0	—
Total	**127**	**100%**	**1,644**	**100%**	**283**	**100%**

Level of evidence for foodborne outbreaks

There was statistical evidence of an association between the consumption of the implicated food and illness for seven foodborne outbreaks in 2018, ascertained from three point-source cohort studies and four case-control studies. An additional six outbreaks had statistical and microbiological evidence of the aetiological agent in the epidemiologically implicated food. In addition to compelling descriptive evidence, microbiological evidence also supported the implicated food in 12 outbreaks. Compelling descriptive evidence alone supported foodborne transmission for the remaining 102 outbreaks in 2018 (Table 27).

Table 27: Number of foodborne outbreaks in Australia by type of evidence and aetiological agent, 2018 (n = 127)

	Evidence type(s)				
Aetiological agent	Statistical[a]	Statistical and microbiological[b]	Compelling descriptive[c]	Microbiological and compelling descriptive	Total
Bacillus cereus	0	0	0	1	1
Campylobacter	0	0	4	0	4
Ciguatoxin	0	0	4	0	4
Clostridium perfringens	0	0	2	0	2
Hepatitis A	0	1	0	0	1
Listeria monocytogenes	0	1	0	1	2
Norovirus	1	0	4	0	5
Salmonella	4	4	53	10	71
Scombrotoxin	0	0	5	0	5
Unknown	2	0	30	0	32
Total	**7**	**6**	**102**	**12**	**127**

a 'Statistical evidence' refers to analytical epidemiological association between illness and one or more foods.

b 'Microbiological evidence' refers to microbiological confirmation of an aetiological agent in the suspected vehicle or food.

c 'Compelling descriptive evidence' refers to descriptive evidence implicating the suspected vehicle or suggesting foodborne transmission.

Point source outbreaks (within multi-jurisdictional outbreaks and large community outbreaks)

From 2018 onwards, point source outbreaks occurring within multi-jurisdictional outbreak investigations and within large community outbreaks have been reported to the OzFoodNet Outbreak Register. Point source outbreaks are smaller contained outbreaks that have occurred as part of a larger outbreak. There were four point source outbreaks reported in 2018, all of which (100%) were reported by New South Wales. All point source outbreaks in 2018 were egg-related, with two associated with *Salmonella* Typhimurium and two associated with *Salmonella* Enteritidis (Appendix C). The two New South Wales *Salmonella* Enteritidis point source outbreaks were related to a broader outbreak investigated by OzFoodNet in 2019 and are therefore reported on in full in the 2019 OzFoodNet Annual Report.

All reports of illness, hospitalisation, or death occurring within a point source outbreak are included within the totals reported for the overarching outbreak.

Multi-jurisdictional foodborne outbreak investigations in 2018

OzFoodNet undertook two multi-jurisdictional outbreak investigations (MJOI) in 2018.

Listeriosis

In February 2018, OzFoodNet initiated a MJOI into highly related cases of listeriosis MLST 240 linked to the consumption of rockmelon. There were 22 confirmed cases linked to the outbreak from four Australian states (eight in Victoria, seven in Queensland, six in New South Wales and one in Tasmania). In addition to the Australian cases, two related cases were identified in Singapore.

Of the 22 Australian cases, infections occurred in 13 females (59%) and nine males (41%), with ages ranging from 0 to 94 years and an average age of 70 years. All cases had an underlying condition which predisposed them to listeriosis infection. All were hospitalised during their illness and seven cases (32%) died from their infection. There were two pregnancy-related infections, one of which resulted in a miscarriage and the other in a pre-term birth. Onset dates occurred between 17 January 2018 and 10 April 2018.

A case-case analysis was conducted using enhanced listeriosis data that included 21 outbreak cases and 42 non-outbreak cases. Where data was available for cases (20/22; 90%), all reported consumption of rockmelon during their incubation period, and 80% reported shopping at one common supermarket chain. The consumption of rockmelon was statistically associated with listeriosis caused by the outbreak strain, with an elevated odds ratio (OR) of 56.97; a 95% confidence interval (95% CI) of 8.67–∞; and $p < 0.001$.

Listeria monocytogenes was detected in rockmelon samples collected from the supermarket chain and supplier implicated in the outbreak. The positive food sample isolates were found to be genomically related to the human case isolates. Food Standards Australia and New Zealand (FSANZ) coordinated a consumer-level recall of rockmelons on 28 February 2018. Following this outbreak, public health actions such as changes to food safety plans and processing operations have been implemented to ensure that future outbreaks are mitigated.[61]

Hepatitis A

In April 2018, OzFoodNet initiated a MJOI into cases of hepatitis A genotype IB linked to consumption of imported frozen pomegranate arils. There were 30 confirmed outbreak cases, including cases reported from New South Wales (15 cases), Victoria (6 cases), Western Australia (3 cases), the Northern Territory (2 cases), South Australia (2 cases), Queensland (1 case) and the Australian Capital Territory (1 case). Confirmed cases included eighteen females and twelve males with an age range of 4–74 years of age (median age 31 years). Of the confirmed cases, 25 (83%) were hospitalised for their illness and one possible death was reported. Three cases (10%) were secondary infections and were epidemiologically linked to an earlier confirmed case. The outbreak occurred over a 138-day period; onsets ranged from 31 January 2018 to 18 June 2018.

A case control study was conducted, enrolling 13 cases and 21 controls matched on age and sex. A multivariable analysis found that consumption of frozen pomegranate arils was associated with illness (OR: 43.4; 95% CI: 4.2–448.8; $p = 0.002$).[62]

Frozen pomegranate arils were the most commonly reported food among cases, with 69% of cases with data available (18/26) reporting consumption. Of these cases, all (18/18) reported purchasing frozen pomegranate arils from the same supermarket chain, which was the exclusive stockist of the implicated product. HAV was detected in an unopen packet of the frozen pomegranate product.

The frozen pomegranate arils were imported from one country and re-packaged in Australia. The investigation of the Australian food processor that repackaged the product in Australia found they were operating with all appropriate hygiene and food safety control processes, concluding that the local food processor had no process deficits to suggest it was the cause of the contamination, and that contamination most likely occurred before the product arrived in Australia. FSANZ co-ordinated a national consumer level recall of frozen pomegranate arils on 7 April 2018.

Animal-to-person and probable animal-to-person outbreaks

There were no gastrointestinal outbreaks where animals were the source of illness in 2018 (Table 21). Animal-to-person outbreaks are rarely identified in Australia, with a total of eight reported in the previous five years, with an average of two animal-to-person outbreaks per year in Australia.

Waterborne and probable waterborne outbreaks

Waterborne outbreaks are rare in Australia. One waterborne outbreak was reported in 2018 (Table 21). This outbreak of unknown aetiology occurred following consumption of contaminated water at a school camp affecting 18 people. There have been a total of nine waterborne outbreaks reported in the previous five years, with an average of two waterborne outbreaks reported per year in Australia.

Environmental and probable environmental outbreaks

There were nine environmental outbreaks reported in 2018, affecting a total of 106 people (Table 21). This was higher than the five-year historical mean of seven environmental outbreaks per year. These nine outbreaks included six cryptosporidium outbreaks following exposure at swimming pools; two norovirus outbreaks, caused by probable environmental contamination at the same wedding venue; and one *S.* Saintpaul outbreak associated with camping and poor hand hygiene. Most environmental outbreaks reported since 2012 have been cryptosporidium outbreaks associated with swimming pools.

Requirements for the review/follow-up of swimming pools and other aquatic facilities, when a single case or cluster of cases of cryptosporidiosis is identified as possibly associated with a facility, vary by state and territory. As a result, not every instance will be reported as an outbreak and therefore may not be recorded in this report. Data on environmental and probable environmental outbreaks should be interpreted with caution.

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Appendix A

Revised OzFoodNet definitions for modes of outbreak transmission implemented in 2016

Mode	Definition
Foodborne	An incident where two or more persons experience a similar illness after consuming a common food or meal and analytical epidemiological evidence and/or microbiological evidence (including food and/or environmental) implicates the meal or food as the source of illness; or the aetiology of the outbreak can only result through foodborne transmission (for example *Listeria monocytogenes*, ciguatera fish poisoning).
Probable foodborne	An incident where two or more persons experience a similar illness after consuming a common food or meal and compelling descriptive epidemiological evidence implicates the meal or food as the suspected source of illness. This includes outbreaks where the mode of transmission is suspected to be from an ill food handler to food to person.
Waterborne	An incident where two or more persons experience a similar illness after the consumption of water from a common source and analytical epidemiological evidence and/or microbiological evidence implicates the drinking water supply as the source of illness. This does not include outbreaks associated with accidental consumption of water during recreational water exposures (environmental transmission).
Probable waterborne	An incident where two or more persons experience a similar illness after consumption of water from a common source and compelling descriptive epidemiological evidence implicates the drinking water supply as the source of illness. This does not include outbreaks associated with accidental consumption of water during recreational water exposures (environmental transmission).
Animal-to-person	An incident where two or more persons experience a similar illness after exposure to animals and analytical epidemiological evidence and/or microbiological evidence implicates the animal as the source of illness.
Probable animal-to-person	An incident where two or more persons experience a similar illness after exposure to animals and compelling descriptive epidemiological evidence implicates the animals as the suspected source of illness.
Environmental	An incident where two or more persons experience a similar illness following exposure to a contaminated environment and epidemiological evidence and/or microbiological evidence implicates a specific environmental source as the cause of illness. This includes recreational exposure to water.
Probable environmental	An incident where two or more persons experience a similar illness following exposure to a contaminated environment and compelling descriptive epidemiological evidence identifies a specific environmental source as the suspected cause of illness but the exact source of contamination is unknown. This includes recreational exposure to water.

Appendix B

Foodborne and probable foodborne outbreak summary for OzFoodNet sites, Australia, 2018

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
MJOI	Jan	Primary production	*Listeria monocytogenes*, MLST 240	24	24	7	AM	Case-case study	Rockmelon	Produce – fresh fruit	Ingestion of contaminated raw products
MJOI	Jan	Imported food	Hepatitis A	31	26	1	AM	Case control study	Imported frozen pomegranate arils	Produce – processed fruit	Ingestion of contaminated raw products
ACT	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-25-13-12-523	6	2	0	D	Case series	Unknown	Not attributed	Unknown
ACT	Feb	Private residence	*Salmonella* Typhimurium, MLVA 03-12-13-09-523	7	1	0	D	Case series	Desserts containing raw egg	Eggs – desserts	Cross contamination from raw ingredients
ACT	Apr	Primary production	*Salmonella* Typhimurium, MLVA 03-10-10-09-496	6	3	0	DM	Case series	Eggs	Eggs – single food	Inadequate cleaning of equipment
ACT	Apr	Restaurant/ café	*Bacillus cereus*	15	0	0	DM	Cohort study	Beef short rib	Meat – beef	Other source of contamination
NSW	Jan	Unknown	*Salmonella* Typhimurium, MLVA 03-09-07-14-523	21	Unknown	0	D	Case series	Unknown	Not attributed	Unknown
NSW	Jan	Restaurant/ café	Unknown (suspected norovirus)	31	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jan	Restaurant/ café	Unknown (suspected viral)	7	0	0	D	No formal study	Unknown	Not attributed	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Jan	Commercial caterer	Unknown (suspected bacterial)	10	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Feb	Take-away	Unknown (suspected toxin)	5	2	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Feb	Restaurant/ café	Unknown	4	0	0	D	No formal study	Lebanese pizza	Mixed/ multiple	Unknown
NSW	Feb	Primary production	Ciguatoxin (ciguatera fish poisoning)	4	0	0	D	No formal study	Mackerel	Seafood – fish	Toxic substance or part of tissue
NSW	Feb	Restaurant/ café	Unknown (suspected toxin)	3	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Feb	Private residence	Scombrotoxin (histamine fish poisoning)	6	3	0	D	No formal study	Yellow fin tuna	Seafood – fish	Toxic substance or part of tissue
NSW	Mar	Restaurant/ café	Unknown	25	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Mar	Private residence	Scombrotoxin (histamine fish poisoning)	2	0	0	D	Case series	Tuna steak	Seafood – fish	Toxic substance or part of tissue
NSW	Mar	Child care	*Salmonella* Typhimurium, MLVA 03-13-07/12-09-523	15	0	0	D	No formal study	Unknown	Not attributed	Cross contamination from raw ingredients; food handler contamination
NSW	Mar	Take-away	Scombrotoxin (histamine fish poisoning)	2	2	0	D	No formal study	Canned tuna	Seafood – fish	Toxic substance or part of tissue
NSW	Apr	Camp	Unknown	31	4	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Apr	Fair/festival/ mobile service	Unknown	3	Unknown	Unknown	D	No formal study	Unknown	Not attributed	Unknown
NSW	Apr	Restaurant/ café	*Salmonella* Infantis	4	1	0	DM	No formal study	Egg dishes	Eggs – single food	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Apr	Commercial caterer	Unknown	44	Unknown	0	D	No formal study	Unknown	Not attributed	Person to food to person
NSW	Apr	Restaurant/ café	*Campylobacter*	7	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	May	Restaurant/ café	Unknown	4	0	0	D	No formal study	Red velvet pancakes	Mixed/ multiple	Unknown
NSW	May	Restaurant/ café	Unknown	5	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	May	Restaurant/ café	Unknown	10	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jun	Restaurant/ café	Unknown	7	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jul	Take-away	Unknown	8	Unknown	Unknown	D	No formal study	Unknown	Not attributed	Unknown
NSW	Aug	Commercial caterer	Unknown	19	1	0	D	Point source cohort	Unknown	Not attributed	Unknown
NSW	Aug	Take-away	Unknown	2	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Aug	Restaurant/ café	Unknown	10	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Sep	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-16-10-17-523	17	2	0	AM	Point source cohort	Tiramisu containing raw egg	Eggs – desserts	Cross contamination from raw ingredients; ingestion of contaminated raw products
NSW	Sep	Aged care	*Clostridium perfringens*	23	0	0	D	No formal study	Unknown	Not attributed	Other source of contamination
NSW	Sep	Take-away	*Salmonella* Virchow	3	0	0	D	Point source cohort	Chicken and mayonnaise sandwich/ wrap containing raw egg butter	Eggs – sauce/ dressing	Inadequate cleaning of equipment

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Oct	Private residence	*Salmonella* Typhimurium, MLVA 05-15-16-11-490	5	Unknown	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Oct	Restaurant/ café	Norovirus	29	0	0	D	Point source analytical cohort	Unknown	Not attributed	Person to food to person
NSW	Dec	Primary production	*Salmonella* Typhimurium, MLVA 05-17-09-13-490	236	63	5	DM	Case series	Eggs	Eggs – single food	Cross contamination from raw ingredients
NSW	Dec	Restaurant/ café	Unknown	8	1	0	D	No formal study	Unknown	Not attributed	Unknown
NT	Jan	Take-away	Unknown (suspected toxin)	9	2	0	D	Case series	Chicken kebab	Meat – poultry	Food handler contamination; ingestion of contaminated raw products
NT	Mar	Correctional facility	Unknown (suspected toxin)	9	1	0	D	No formal study	Chicken	Meat – poultry	Not applicable
NT	Jul	Private residence	*Salmonella* Ball	23	2	0	A	Point source cohort	Chap Soy	Mixed/ multiple	Other source of contamination
NT	Aug	Restaurant/ café	Norovirus	32	0	0	D	Case series	Unknown	Not attributed	Person to food to person
NT	Aug	Restaurant/ café	Unknown	2	0	0	D	No formal study	Vegetable daal and rice	Mixed/ multiple	Unknown
NT	Sep	Take-away	Unknown (suspected toxin)	2	2	0	D	Case series	Chicken kebab	Meat – poultry	Ingestion of contaminated raw products
Qld	Jan	Primary production	Ciguatoxin (ciguatera fish poisoning)	2	0	0	D	Case series	Spanish mackerel	Seafood – fish	Toxic substance or part of tissue
Qld	Jan	Primary production	Ciguatoxin (ciguatera fish poisoning)	3	0	0	D	Case series	Mixed reef fillets	Seafood – fish	Toxic substance or part of tissue

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Qld	Feb	Primary production	Scombrotoxin (histamine fish poisoning)	7	1	0	D	Case series	Yellow fin tuna	Seafood – fish	Toxic substance or part of tissue
Qld	Mar	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-12-15-10-523	4	1	0	D	Case series	Unknown	Not attributed	Unknown
Qld	Apr	Restaurant/ café	Unknown (suspected bacterial toxin)	6	1	0	D	Case series	Unknown	Not attributed	Unknown
Qld	Apr	Primary production	Ciguatoxin (ciguatera fish poisoning)	4	Unknown	0	D	Case series	Coral trout	Seafood – fish	Toxic substance or part of tissue
Qld	Apr	Aged care	*Salmonella* Waycross	4	3	0	D	Case series	Baked ham and egg	Mixed/ multiple	Unknown
Qld	Jul	Fair/festival/ mobile service	*Salmonella* Oranienburg	3	0	0	D	Case series	Vegetarian paella	Mixed/ multiple	Unknown
Qld	Jul	Restaurant/ café	*Campylobacter*	2	0	0	D	Case series	Lamb kebab	Mixed/ multiple	Unknown
Qld	Aug	National franchised fast food	Norovirus	33	0	0	A	Point source cohort	Sandwich rolls/wraps containing meat	Mixed/ multiple	Person to food to person
Qld	Aug	Commercial caterer	Norovirus	20	1	0	D	Case series	Unknown	Not attributed	Person to food to person; storage in contaminated environment
Qld	Oct	Aged care	*Clostridium perfringens*	2	2	0	D	Case series	Spaghetti bolognaise	Meat – not further specified	Unknown
Qld	Dec	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-13-15-10-523	5	0	0	D	Case series	Rice paper rolls	Mixed/ multiple	Cross contamination from raw ingredients; inadequate cleaning of equipment

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
SA	Jan	Restaurant/ café	*Salmonella* Typhimurium, PT 9, MLVA 03-24-11-10-523	7	1	0	D	Case series	Multiple foods including egg based dishes	Eggs – single food	Cross contamination from raw ingredients; inadequate cleaning of equipment
SA	Jan	Restaurant/ café	*Salmonella* Typhimurium, PT 135, MLVA 03-14-10-08-523	8	4	0	D	Case series	Mulitple foods	Mixed/ multiple	Cross contamination from raw ingredients; inadequate cleaning of equipment
SA	Jan	Private residence	*Salmonella* Typhimurium, PT 12a, MLVA 05-15-17-09-490	5	0	0	D	Case series	Unknown	Not attributed	Unknown
SA	Jan	Correctional facility	*Campylobacter jejuni*	5	0	0	D	No formal study	Unpasteurised cream	Dairy – milk/ cream	Ingestion of contaminated raw products
SA	Feb	Restaurant/ café	*Salmonella* Typhimurium, PT 44, MLVA 03-10-08-09-523	28	5	0	DM	Case series	Raw egg mayonnaise	Eggs – sauce/ dressing	Inadequate cleaning of equipment; ingestion of contaminated raw products
SA	Apr	Aged care	*Salmonella* Typhimurium, PT 135a, MLVA 03-12-07-11-523	7	1	0	D	Case series	Unknown	Not attributed	Cross contamination from raw ingredients; food handler contamination
SA	May	Primary production	*Salmonella* Havana	31	11	0	AM	Case control study	Alfalfa sprouts	Produce – fresh vegetable	Ingestion of contaminated raw products
SA	Jun	Commercial caterer	*Listeria monocytogenes*, MLST 3	3	3	0	DM	Case series	Unknown	Not attributed	Other source of contamination

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
SA	Jul	Primary production	*Salmonella* Oranienburg	27	2	0	DM	Case control study	Alfalfa sprouts	Produce – fresh vegetable	Ingestion of contaminated raw products
SA	Nov	Private caterer	*Salmonella* Typhimurium, PT 108, MLVA 04-11-15-00-517	5	0	0	D	Case series	Unknown	Not attributed	Other source of contamination
SA	Dec	Restaurant/ café	*Salmonella* Typhimurium, PT 9, MLVA 03-23-12/13-10-523	5	3	0	D	Case series	Multiple foods including eggs and egg based sauces	Eggs – sauce/ dressing; eggs – other	Cross contamination from raw ingredients; ingestion of contaminated raw products
Tas.	Jan	Primary production	*Salmonella* Typhimurium	44	12	0	DM	Case series	Chicken	Meat – poultry	Other source of contamination
Tas.	Jul	Restaurant/ café	Unknown	6	0	0	D	Case series	Unknown	Not attributed	Unknown
Tas.	Aug	Restaurant/ café	Norovirus	14	0	0	D	Point source cohort	Unknown	Not attributed	Food handler contamination
Vic.	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-12-10-10-523	12	1	0	DM	Case series	Raw egg butter	Eggs – sauce/ dressing	Ingestion of contaminated raw products
Vic.	Jan	Private residence	*Salmonella* Typhimurium, MLVA 03-14-11-08-523	13	8	0	DM	Case series	Chicken or Turkey	Meat – poultry	Unknown
Vic.	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-24-12-11-523	23	1	0	DM	Point source cohort	Raw egg mayonnaise	Eggs – sauce/ dressing	Ingestion of contaminated raw products
Vic.	Jan	National franchised fast food	*Salmonella* Bovismorbificans	36	5	0	D	Case series	Burgers or wraps containing salads	Mixed/ multiple	Ingestion of contaminated raw products

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Vic.	Feb	Private residence	Scombrotoxin (histamine fish poisoning)	6	1	0	D	Case series	Kingfish	Seafood – fish	Toxic substance or part of tissue
Vic.	Feb	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-15-10-11-523	2	1	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Feb	Take-away	*Salmonella* Typhimurium, MLVA 03-15-10-11-523	8	0	0	D	Case series	Multiple foods	Mixed/ multiple	Cross contamination from raw ingredients
Vic.	Feb	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-15-10-11-523	8	1	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Apr	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-15-10-11-523	10	0	0	D	Case series	Dumplings	Mixed/ multiple	Ingestion of contaminated raw products
Vic.	May	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-15-11-10-523	19	2	0	A	Point source cohort	Chocolate mousse containing raw egg	Eggs – desserts	Ingestion of contaminated raw products
Vic.	Jul	Private residence	*Salmonella* Typhimurium, MLVA 03-15-12-11-523	16	3	0	D	Case series	Chicken	Meat – poultry	Cross contamination from raw ingredients
Vic.	Sep	Aged care	Unknown (suspected *Clostridium perfringens*)	8	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Sep	Aged care	Unknown (suspected *Clostridium perfringens*)	5	0	0	D	Case series	Unknown	Not attributed	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Vic.	Oct	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-14-17-09-523	37	2	0	AM	Case control study	Salmon with pureed peas	Mixed/ multiple	Cross contamination from raw ingredients
Vic.	Oct	Restaurant/ café	*Campylobacter*	3	0	0	D	Case series	Pork belly	Meat – pork	Unknown
Vic.	Nov	Restaurant/ café	Unknown (suspected toxin)	8	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Dec	Private residence	*Salmonella* Typhimurium, MLVA 03-12-07-11-523	11	Unknown	0	D	Case series	Hedgehog slice containing raw egg	Eggs – desserts	Ingestion of contaminated raw products
Vic.	Dec	Private residence	*Salmonella* Typhimurium, MLVA 03-25-12-10-523	10	8	0	DM	No formal study	Eggnog	Eggs – drink	Ingestion of contaminated raw products
WA	Jan	Private residence	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	3	3	0	D	No formal study	Unknown	Not attributed	Unknown
WA	Jan	Private residence	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	6	1	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-10-12-523	5	2	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	19	6	0	D	Case series	Raw egg mayonnaise	Eggs – sauce/ dressing	Ingestion of contaminated raw products
WA	Jan	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	21	5	0	D	Case series	Egg dishes	Eggs – single food	Ingestion of contaminated raw products

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Feb	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	3	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Feb	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-11-523	5	1	0	D	Case control study	Unknown	Not attributed	Unknown
WA	Feb	Private residence	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	3	0	0	D	No formal study	Beef casserole topped with lightly cooked egg	Eggs – single food	Ingestion of contaminated raw products
WA	Mar	Restaurant/ café	*Salmonella* Bovismorbificans	2	2	0	D	Case series	Kebab	Mixed/ multiple	Ingestion of contaminated raw products
WA	Mar	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	5	1	0	D	Case series	Unknown	Not attributed	Unknown
WA	Mar	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-26-17-12-523	11	3	0	D	Case control study	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Mar	Mining camp	*Salmonella* Bovismorbificans	5	1	0	D	Case control study	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Mar	Mining camp	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	2	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Apr	Student accommodation	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	13	2	0	A	Case control study	Coleslaw containing raw egg mayonnaise	Eggs – sauce/ dressing	Ingestion of contaminated raw products
WA	Apr	Aged care	Unknown	12	0	0	D	Case series	Unknown	Not attributed	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Apr	Aged care	Unknown (suspected *Clostridium perfringens*)	12	0	0	D	Case series	Unknown	Not attributed	Inadequate cleaning of equipment
WA	Apr	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	2	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Apr	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	19	6	0	A	Case control study	Raw egg sauces	Eggs – sauce/ dressing	Other source of contamination
WA	May	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	10	2	0	D	Case control study	Unknown	Not attributed	Cross contamination from raw ingredients; inadequate cleaning of equipment
WA	May	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-11-523	8	3	0	D	Case series	Unknown	Not attributed	Unknown
WA	May	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-12-11-10-523	3	2	0	D	Case series	Chocolate molten lava cake containing raw egg	Eggs – desserts	Ingestion of contaminated raw products
WA	May	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	7	0	0	AM	Case control study	Fried ice cream	Eggs – desserts	Cross contamination from raw ingredients; ingestion of contaminated raw products
WA	Jun	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-11-17-11-496	2	1	0	D	Case series	Smoked salmon sandwich	Mixed/ multiple	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Jul	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	7	2	0	D	Case series	Raspberry mousse containing raw egg	Eggs – desserts	Ingestion of contaminated raw products
WA	Jul	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-26-16-13-523	4	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jul	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-13-11/13-10-523	6	2	0	D	Case series	Raw egg miso aioli	Eggs – sauce/ dressing	Ingestion of contaminated raw products
WA	Aug	Private residence	*Salmonella* Typhimurium, MLVA 03-14-10-08-523	7	4	0	D	Case control study	Unknown	Not attributed	Unknown
WA	Aug	Private residence	*Salmonella* Typhimurium, MLVA 03-25-18-11-523	4	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Aug	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	3	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Sep	Correctional facility	*Salmonella* Typhimurium, MLVA 03-11-15-10-523	36	1	0	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Oct	Commercial caterer	Unknown (suspected viral)	24	0	0	A	Case control study	Sandwiches	Mixed/ multiple	Food handler contamination, Person to food to person
WA	Oct	Correctional facility	*Salmonella* Typhimurium, MLVA 03-11-15-10-523	11	1	0	D	Case series	Raw egg milkshake	Eggs – drink	Ingestion of contaminated raw products

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill	Number hospitalised	Number of fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Oct	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-11-12-523	3	0	0	D	No formal study	Unknown	Not attributed	Unknown
WA	Nov	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	10	2	0	D	Case control study	Raw egg aioli	Eggs – sauce/ dressing	Ingestion of contaminated raw products
WA	Nov	Restaurant/ café	Unknown (suspected viral)	19	0	0	A	Case control study	Noodle salad	Mixed/ multiple	Unknown
WA	Nov	Take-away	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	28	3	0	D	Case series	Vietnamese pork roll containing raw egg mayonnaise	Eggs – sauce/ dressing	Ingestion of contaminated raw products
WA	Dec	Restaurant/ café	*Salmonella* Typhimurium, MLVA 03-17-09-12-523	3	1	0	D	Case series	Vietnamese pork rolls containing commercial mayonnaise	Mixed/ multiple	Unknown

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

b Month of outbreak is the month of onset of the first case or the month of notification of the first case or the month in which the investigation into the outbreak commenced.

c MLST: multi-locus sequence type; MLVA: multi-locus variable number tandem repeat analysis; PT: phage type.

d A: analytical epidemiological association between illness and one or more foods; D: descriptive evidence implicating the suspected vehicle or suggesting foodborne transmission; M: microbiological confirmation of aetiological agent in the suspected vehicle and cases.

Appendix C

Point source foodborne and probable foodborne outbreaks within multi-jurisdictional outbreaks and large community outbreaks, summary for OzFoodNet sites, Australia, 2018

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	Number ill[d]	Number hospitalised[d]	Number of fatalities[d]	Evidence[e]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Sep	Restaurant/ café	*Salmonella* Enteritidis	30	1	0	DM	Point source cohort	Unknown	Not attributed	Cross contamination from raw ingredients; inadequate cleaning of equipment
NSW	Oct	Restaurant/ café	*Salmonella* Enteritidis	3	1	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Nov	Aged care	*Salmonella* Typhimurium, MLVA 05-17-09-13-490	17	4	0	DM	Case series	Eggs	Eggs – single food	Cross contamination from raw ingredients
NSW	Dec	Take-away	*Salmonella* Typhimurium, MLVA 05-17-09-13/14-490	13	6	0	D	No formal study	Raw egg mayonnaise	Eggs – sauce/ dressing	Cross contamination from raw ingredients

a NSW: New South Wales.

b Month of outbreak is the month of onset of the first case or the month of notification of the first case or the month in which the investigation into the outbreak commenced.

c MLVA: multi-locus variable number tandem repeat analysis.

d Counts of ill persons, hospitalisations and deaths reported within point source outbreaks have already been included within the overarching larger outbreak and should not be added to the values reported in Appendix B.

e A: analytical epidemiological association between illness and one or more foods; D: descriptive evidence implicating the suspected vehicle or suggesting foodborne transmission; M: microbiological confirmation of aetiological agent in the suspected vehicle and cases.