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Monitoring the incidence and causes of disease potentially transmitted by food in Australia: Annual report of the OzFoodNet network, 2017

The OzFoodNet Working Group

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Annual report

Monitoring the incidence and causes of disease potentially transmitted by food in Australia: Annual report of the OzFoodNet network, 2017

The OzFoodNet Working Group

Abstract

In 2017, 47,652 notifications of enteric diseases potentially related to food were received by state and territory health departments in Australia. Consistent with previous years, the majority of all notified infections were either campylobacteriosis (n = 28,432; 60%) or salmonellosis (n = 16,416; 34%). A total of 206 gastrointestinal outbreaks, including 179 foodborne outbreaks, were reported in 2017. The remaining 27 outbreaks were due to environmental or probable environmental transmission (22 outbreaks), animal-to person or probable animal-to-person transmission (three outbreaks), and waterborne or probable waterborne transmission (two outbreaks). Foodborne outbreaks affected 2,130 people resulting in at least 290 hospital admissions and five deaths. Eggs continue to be a source of *Salmonella* Typhimurium infection across the country, with 49 egg-related outbreaks affecting at least 746 people reported across six jurisdictions in 2017.

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.[1–3]

The OzFoodNet network was established in 2000 by the Australian Government Department of Health and Aged Care 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 and Water Resources (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 2017 to 31 December 2017 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 2017 and 31 December 2017.

Methods

Population under surveillance

In 2017, the OzFoodNet network covered all Australian states and territories, with an estimated population of 24,597,528 persons as at 30 June 2017.[4]

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 September 2018 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 that a health department received the notification. Notifications for 2017 include those with a diagnosis date from 1 January 2017 to 31 December 2017. Estimated resident populations for each state or territory as at 30 June 2017 were used to calculate rates of notified infections.[4] 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 OzFoodNet 2016 annual report for more information).[5] 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 phylogenetic analysis was conducted for all human *L. monocytogenes* isolates to identify potential clusters for investigation (data not included).

Enhanced national surveillance for hepatitis A

In July 2017, CDNA endorsed the commencement of a hepatitis A enhanced surveillance pilot study, to determine the usefulness of

i For further information see http://www.health.gov.au/internet/main/Publishing.nsf/Content/cda-surveil-nndss-nndssintro.htm.

ii CDNA national guidelines for public health units. Listeriosis: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-listeriosis.htm.

sequencing strains from all notified cases of hepatitis A nationally over a period of two years. The pilot study commenced on 1 July 2017.

The objectives of the pilot are to:

- better understand hepatitis A molecular epidemiology in Australia through the conduct of national enhanced surveillance for 24 months through genotyping and sequencing RNA from each case and recording specific risk factor information in a centralised database; and
- evaluate the effectiveness (including the cost effectiveness) of national enhanced hepatitis A surveillance at the end of the 24-month trial.

Alongside these pilot objectives, specific surveillance objectives during the 24-month trial are to:

- understand the risk factors and molecular epidemiology of hepatitis A in Australia; and
- detect clusters of locally acquired hepatitis A to enable rapid public health action.

The pilot study 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 used to refer to 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 2012 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 annual report, 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.

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 28% of people experiencing gastroenteritis seek medical attention.[1] 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.[1,6,7]

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. 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 number 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 2017.

Data analysis

All analyses were conducted using Microsoft Excel. ■

Results

Notified infections

A total of 47,652 enteric diseases notifications were reported in 2017 (Table 1).

Data from the NNDSS including number of notifications and rate by month, jurisdiction, age group and sex dating back to 1991 can be accessed on the Introduction to the National Notifiable Diseases Surveillance System web page.[iii] A summary of each notifiable enteric condition is provided in this report.

iii https://www1.health.gov.au/internet/main/Publishing.nsf/Content/cda-surveil-nndss-nndssintro.htm.

Table 1: Enteric disease notifications in Australia, 2017

Disease	Number of notifications 2017	Proportion of all enteric notifications 2017	Mean notifications 2012–2016	% change	2017 rate per 100,000 population
Campylobacteriosis[a]	28,432	60%	19,412	46%	133.9
Salmonellosis	16,416	34%	15,035	9%	66.7
Shigellosis	1,745	4%	913	91%	7.1
Shiga toxin-producing *Escherichia coli* (STEC) infection	496	1%	180	176%	2.0
Hepatitis A	216	< 1%	182	19%	0.9
Typhoid fever	143	< 1%	121	18%	0.6
Listeriosis	71	< 1%	81	-12%	0.3
Paratyphoid fever	68	< 1%	75	-9%	0.3
Hepatitis E	47	< 1%	42	12%	0.2
Haemolytic uraemic syndrome (HUS)	14	< 1%	17	-18%	0.1
Botulism	2	< 1%	2	0%	< 0.01
Cholera	2	< 1%	3	-33%	< 0.01
Total	**47,652**	**100%**	**36,063**	**32%**	

a New South Wales commenced notifications in April 2017. New South Wales notifications are included in the notification total, but are not included in the rate calculations. (See campylobacteriosis section.)

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 preformed botulinum toxin (foodborne botulism) or ingesting food, dust or soil that contains the bacteria that produce the toxin (intestinal botulism) or contaminating 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, one 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.

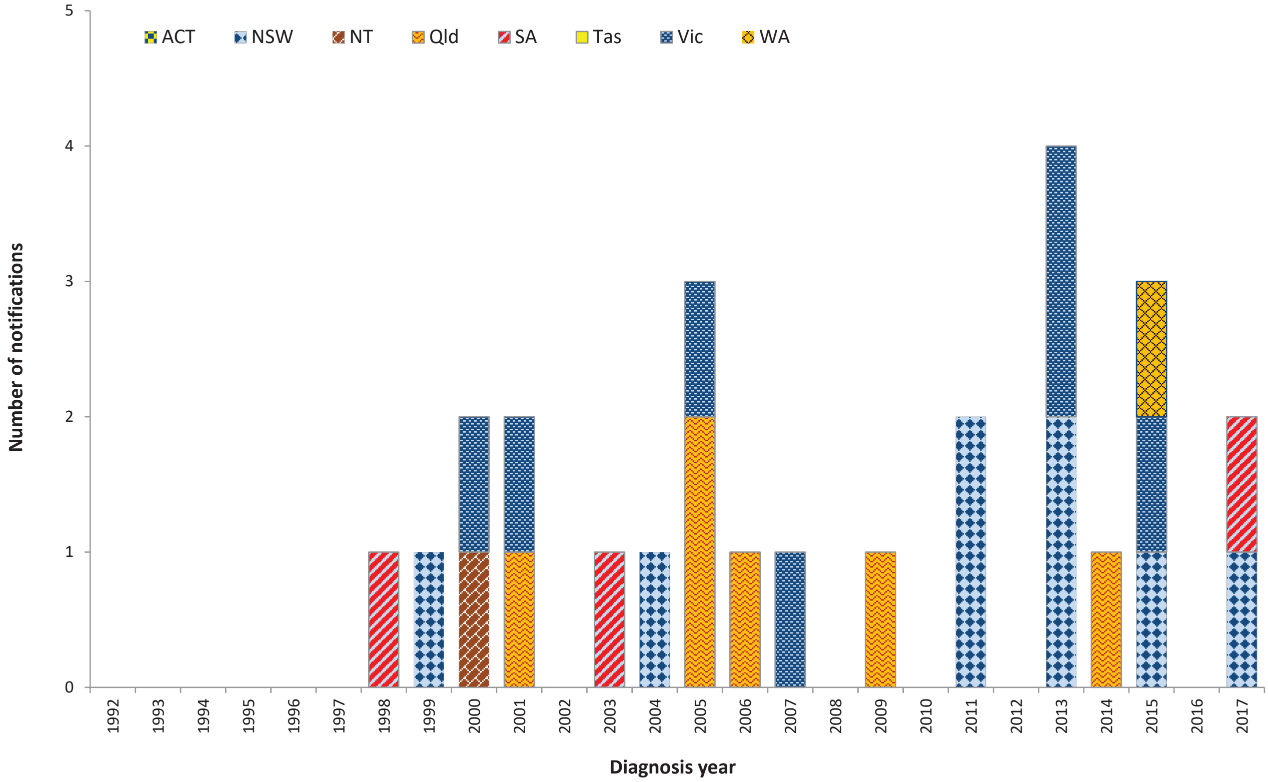
Epidemiology of botulism in Australia, 2017

New South Wales and South Australia each reported a single case of infant botulism in 2017, both of which were in children less than one year of age. No high-risk foods were identified. ■

iv Botulism case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_botsm.htm.

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

Figure 1: Botulism notifications in Australia by jurisdiction of residence, 1992–2017



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.[8] In Australia, it is commonly associated with the consumption of undercooked poultry.[9] Campylobacteriosis may also be acquired through consumption of cross-contaminated foods, animal to person transmission, consumption of unpasteurised milk, and contaminated water.

Surveillance data includes confirmed cases only from all jurisdictions, noting 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 notification began in 1991 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 processing operations in several jurisdictions.[10,11]
- The marked increase in notifications since 2014 occurring throughout Australia is at least in part due to the increase in PCR testing as a method of laboratory diagnosis.
- A slight decline in the national notification rate (excluding New South Wales from the calculation) was observed in 2017 (133.9 cases per 100,000 population) compared with 2016 (146.9 cases per 100,000 population) due to minor decreases in notifications received in all reporting jurisdictions except Queensland (who reported a 4% increase).

Previous outbreaks in Australia

- Foodborne outbreaks have been reported each year in Australia, commonly associated with consumption of poultry, particularly chicken and duck liver pâté. However, outbreaks account for a small number of cases compared with the overall number of cases reported annually.

Epidemiology of campylobacteriosis in Australia, 2017

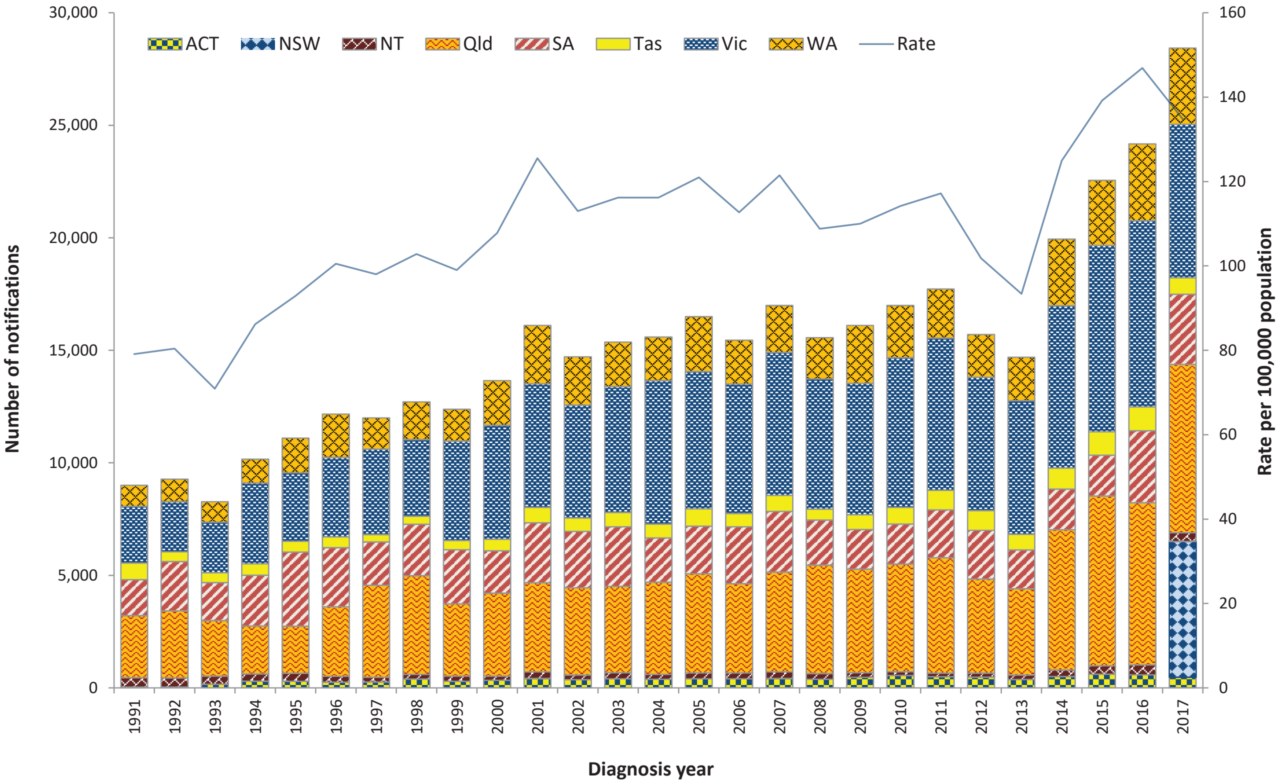
- Campylobacteriosis was the most commonly notified enteric pathogen in 2017, despite only becoming notifiable in New South Wales in April 2017 (Table 1).
- The highest rates of infection occurred in children aged 0–4 years.
- In the Northern Territory, where Indigenous status was available for 98% of children aged 0–4 years (142/145), the notification rate was higher in Aboriginal and/or Torres Strait Islander children (13.1 cases per 1,000 children) compared with non-indigenous children (3.2 cases per 1,000 children).[vii]
- A higher incidence was observed amongst males in every age group when compared with females (Figure 3). While consistent with previous years, the reason for this remains unclear.[8]
- Speciation information was available for 25% of cases (n = 6,998),[viii] with 84% identified as *Campylobacter jejuni* (n = 5,879). ■

vi Campylobacteriosis case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_campy.htm.

vii Cases with unknown Indigenous status were included in the calculation of the non-Indigenous rate (n = 3).

viii Note that not all jurisdictions perform routine speciation analysis for *Campylobacter*.

Figure 2: Campylobacteriosis notifications[a] and rate[b] per 100,000 population in Australia by jurisdiction of residence, 1991–2017



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

b Notifications in New South Wales in 2017 have been excluded from the rate calculation to avoid comparisons of incomplete data. The rate for Australia for 2017 has been calculated using ABS estimated resident population data for Australia minus New South Wales.

Table 2: Summary of campylobacteriosis notifications in Australia,[a] 2017

Category	Value
Number of notifications	28,432
Rate[b]	133.9 cases per 100,000 population
Jurisdiction with the highest number of notifications	Queensland (n = 7,479; 26%)
Seasonality	More common in warmer months with 20% of notifications in January and February (n = 4,567)
Foodborne outbreaks	Six
Foods implicated in outbreaks	Chicken (n = 1), lamb liver (n = 1), pâté (n = 1), raw milk (n = 1) and unknown (n = 2) (Refer to *Foodborne outbreaks* section)

a New South Wales commenced notifications in April 2017.

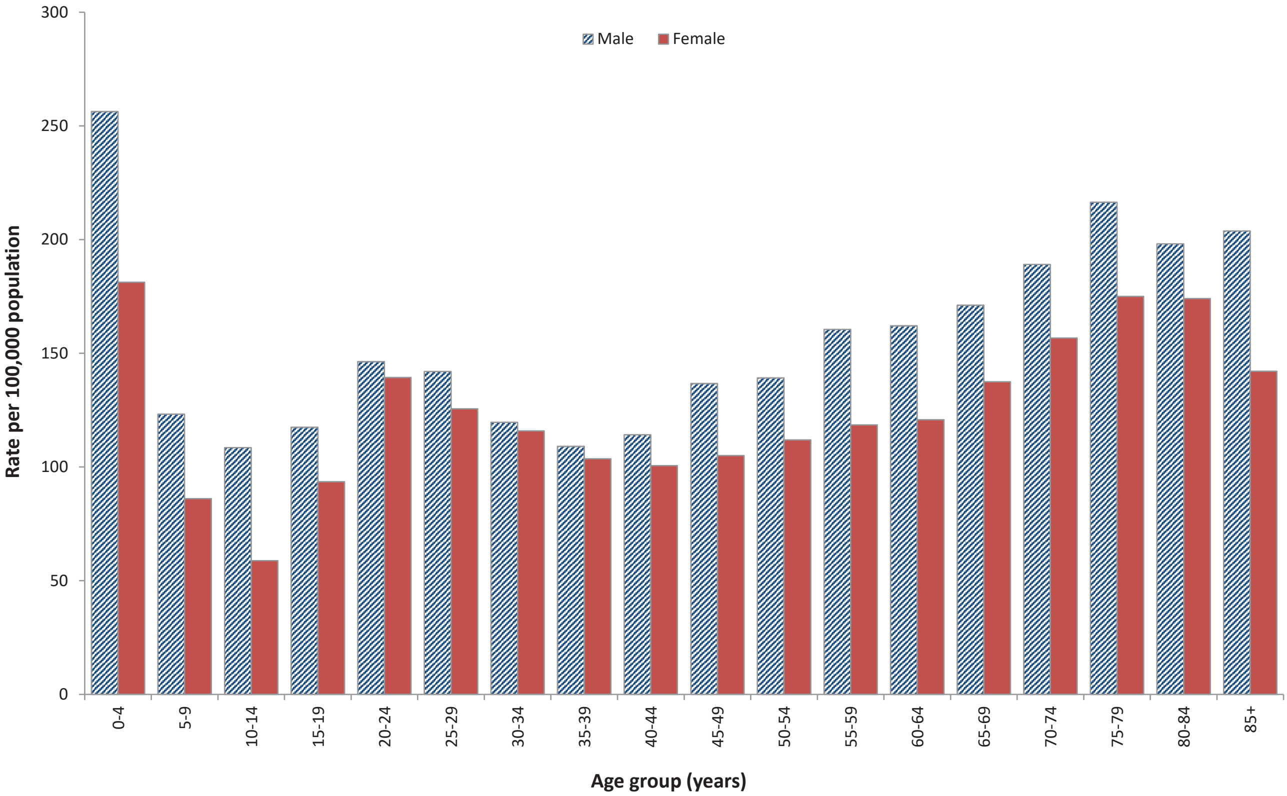
b New South Wales 2017 notifications have been excluded from the rate calculation to avoid comparisons of incomplete data. The rate for Australia for 2017 has been calculated using ABS estimated resident population data for Australia minus New South Wales.

Table 3: Demographics of cases with the highest campylobacteriosis notification rates in Australia,[a] 2017

Category	Group most affected	Rate per 100,000 population	Number (% of all cases)
Age group (years)	0–4	220.4	2,373 (11%)
Sex	Males	148.0	12,288 (55%)
Jurisdiction	South Australia	180.5	3,112 (14%)

a Excluding New South Wales.

Figure 3: Campylobacteriosis notification rate per 100,000 population in Australia[a] by age group and sex, 2017



a Excluding New South Wales.

Cholera

Cholera is an infection of the digestive tract caused by certain strains of the bacterium *Vibrio cholerae* that produce toxins. 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.[ix] All notified cases are followed up by jurisdictional public health staff.

Overall trend

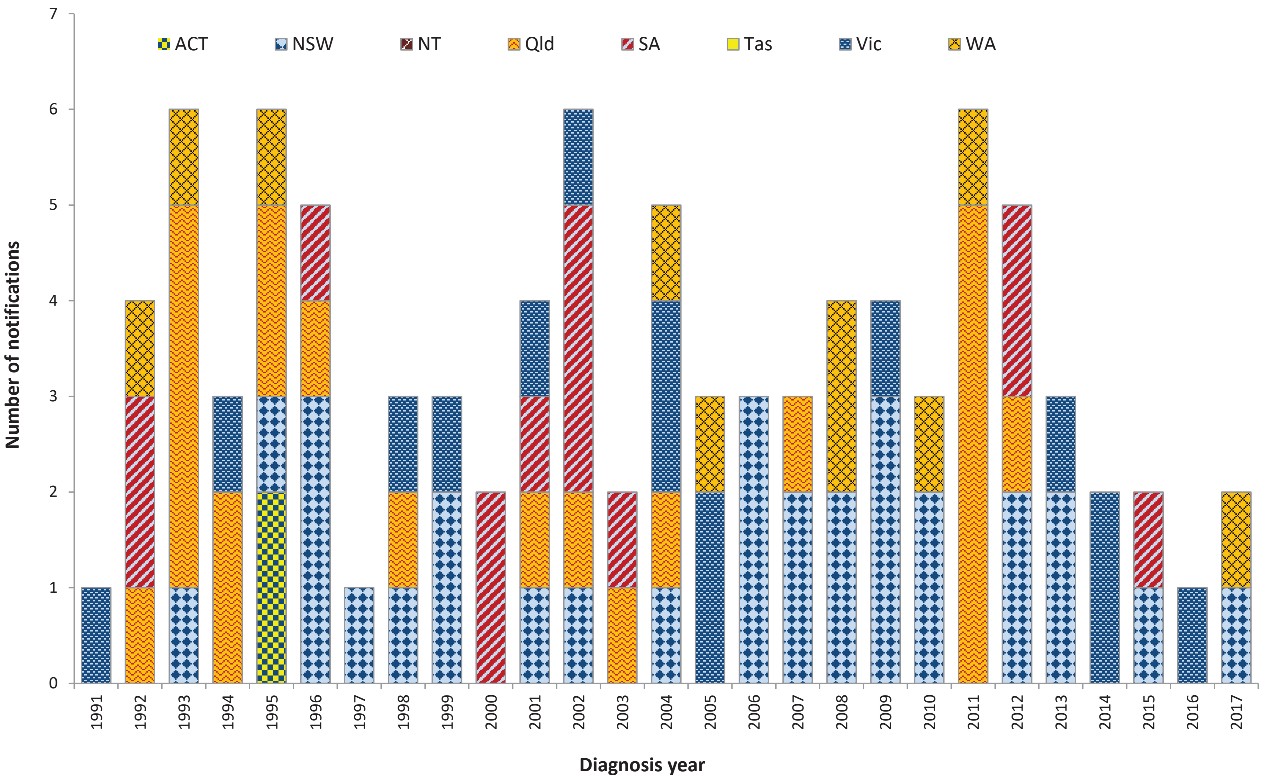
- All cases of cholera reported since 1991 (the commencement of the NNDSS) were acquired outside Australia, with the exception of:
    - one laboratory acquired case in 1996;[12]
    - three cases in 2006 linked to imported whitebait;[13] and
    - one laboratory acquired case in 2013.[14]

Epidemiology of cholera in Australia, 2017

Two cases of cholera were notified in 2017 (Figure 4). Both cases were associated with overseas travel. One case travelled to Thailand, and the other case travelled to the Philippines. ■

ix Cholera case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_cholra.htm.

Figure 4: Cholera notifications in Australia by jurisdiction of residence, 1991–2017



Enteric fever

Typhoid and paratyphoid fever are grouped together as enteric fever as both diseases cause a similar illness, though paratyphoid fever is often less severe and less common. Typhoid fever is caused by the bacterium *Salmonella 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 gastro-enteritis infection caused by other *Salmonella enterica* subsp. *enterica* serovars. Enteric fever is rarely acquired in Australia with almost all 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] Consumption of ready to eat foods, especially raw fruits and 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.[x,xi] All notified cases are followed up by jurisdictional public health staff.[xii]

Overall trend

- Given 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 remained relatively steady in recent years with a slight decline reported in 2017 (Figure 5).
- Minor fluctuations in typhoid fever notifications have occurred in recent years with a slightly higher rate observed in 2017 (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).[16]
- 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.

Epidemiology of enteric fever in Australia, 2017

- Just over half of the typhoid cases notified in 2017 were in females (n = 73; 51%), and the distribution was even for paratyphoid cases (males n = 34; 50%).
- The median age at onset was 24 years for typhoid cases (range 0–85 years) and 29 years for paratyphoid cases (range 1–66 years).
- Consistent with previous years, the majority of typhoid cases were phage type E1 (n = 27; 19%) and E9 (n = 9; 6%). Phage typing was unknown or unable to be performed for 90 cases (63%).

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x Typhoid fever case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_typhi.htm.

xi Paratyphoid case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_paratyhoid.htm.

xii CDNA national guidelines for public health units. Typhoid and paratyphoid fevers: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-typhoid-paratyphoid.htm.

Figure 5: Typhoid fever and paratyphoid fever notifications and enteric fever notification rate per 100,000 population in Australia, 1991–2017

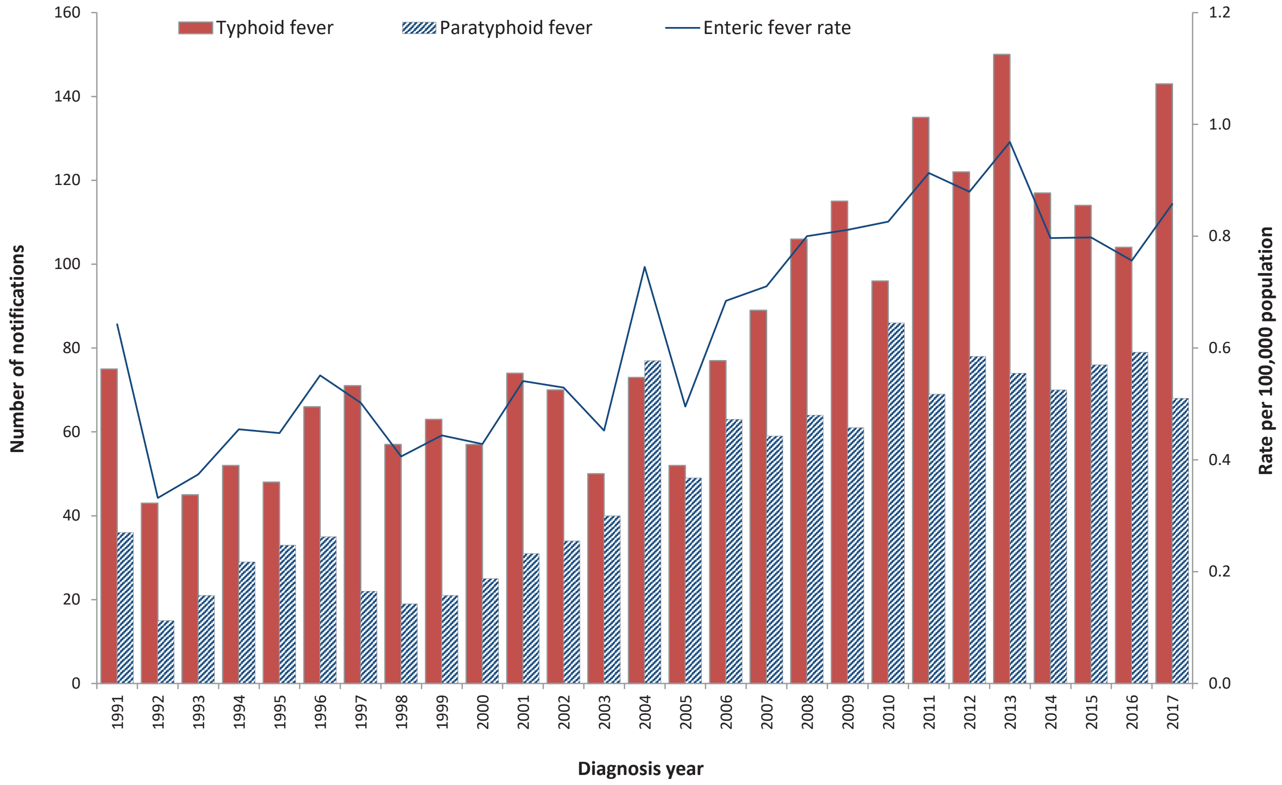


Figure 6: Typhoid fever notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2017

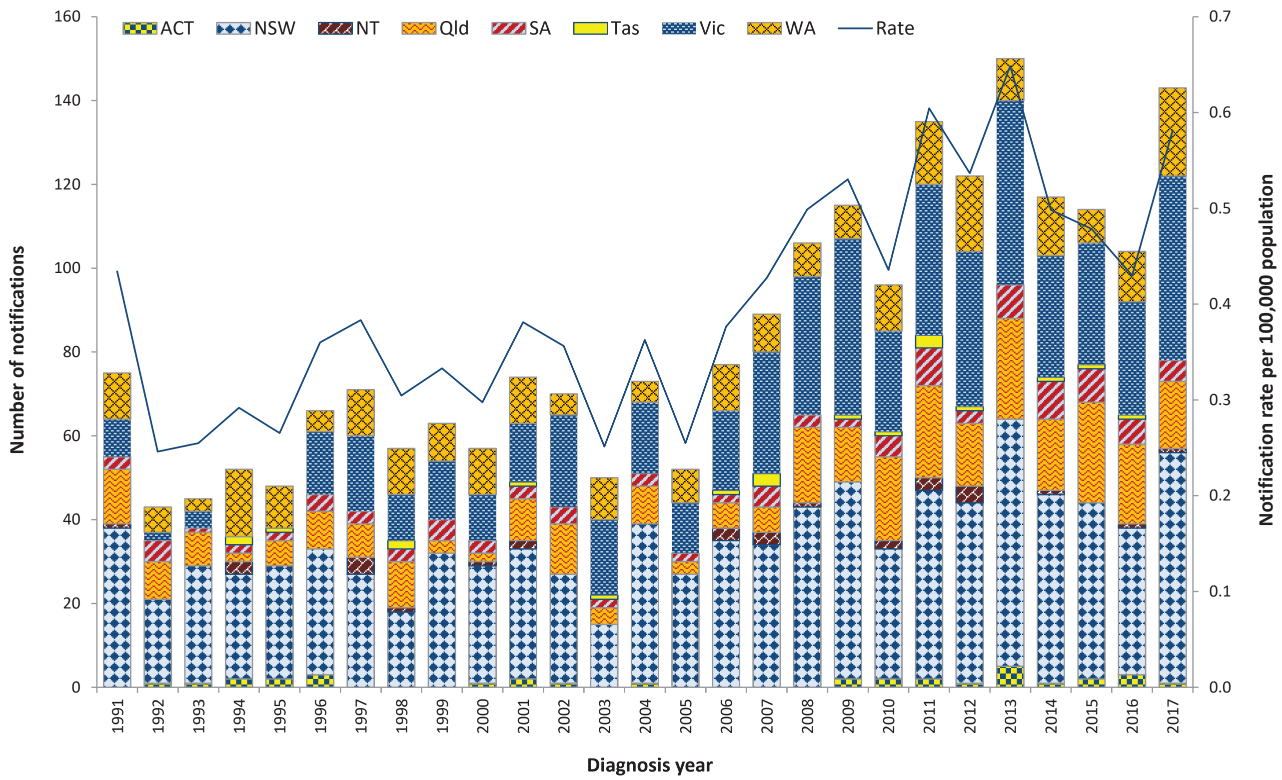


Figure 7: Paratyphoid fever notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2017

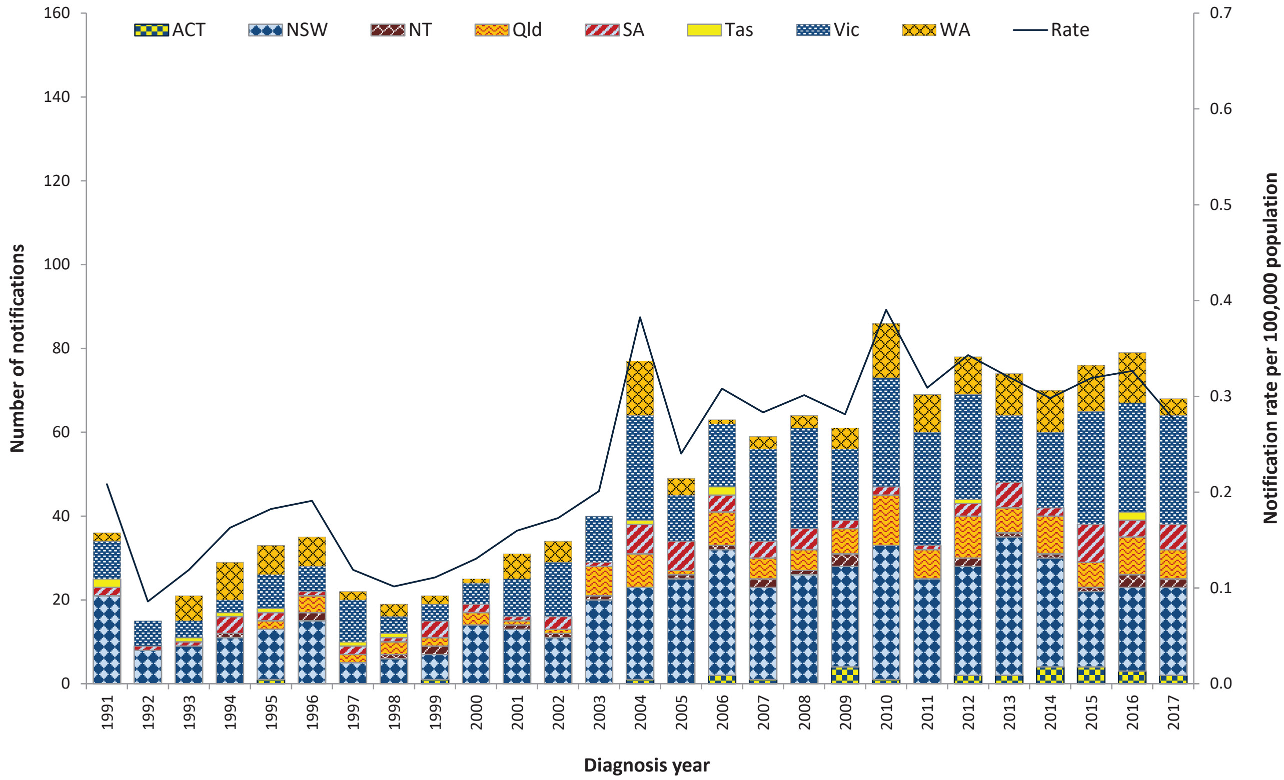


Table 4: Summary of enteric fever notifications in Australia, 2017

	Typhoid fever	Paratyphoid fever
Number of notifications	143	68
Rate	0.6 cases per 100,000 population	0.3 cases per 100,000 population
Jurisdiction with highest number of notifications	New South Wales (n = 55; 38%)	Victoria (n = 26; 38%)
Hospitalisations (% of all cases)	83 (58%)	35 (51%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	0	0
Foodborne outbreaks	0	0

a Indigenous status was not known for 13 typhoid and eight paratyphoid cases.

- Consistent with previous years, the majority of paratyphoid cases were Paratyphoid A (n = 59; 87%) with the remaining cases Paratyphoid B (n = 8; 12%) and unknown (n = 1; 1%).

Country of acquisition

- As seen in previous years, almost all enteric fever cases in 2017 were acquired outside of Australia, with 99% (n = 140) of typhoid and 97% (n = 66) of paratyphoid cases 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 2017, New South Wales, Victoria and Queensland each reported a single typhoid case without a history of overseas travel in their incubation period. The New South Wales case had recently travelled interstate,

Table 5: Top countries of acquisition for overseas acquired enteric fever cases in Australia, 2017

Disease	Country of acquisition	Number of notifications, 2017[a]	Proportion of overseas acquired cases, 2017[a]	Mean 2012–2016
Typhoid fever	India	75	54%	66
	Bangladesh	14	10%	10
	Pakistan	14	10%	9
Paratyphoid fever	India	35	56%	26
	Pakistan	8	13%	3
	Bangladesh	6	10%	4

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

however no definitive source of infection was identified, while the Queensland and Victorian cases were likely chronic carriers with the organism isolated from a hepatic abscess and gall bladder fluid respectively.

- A single Australian-acquired paratyphoid case was reported in 2017 in a Victorian resident with a history of household contact with overseas travellers. ■

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, child care 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,[xiii] the majority of HAV infections diagnosed in Australia are acquired while travelling overseas.[17] Foodborne transmission occurs rarely, although in 2009 and 2015 there were two 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.[xiv] 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.[xv] In July 2017, a pilot project for enhanced national surveillance for hepatitis A commenced. This involves genomic sequencing of virus from all HAV cases in Australia for a period of two years.

Overall trend

- The incidence of HAV has markedly declined in Australia since notification began (Figure 7).
- The number of notifications in 2017 (n = 216) was 19% higher than the five-year historical mean (n = 182) and was due to outbreaks within Australia (further described below).

Previous outbreaks in Australia

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

- oysters (n = 547 cases) predominantly in New South Wales in 1997;[18,19]
- imported semi-dried tomatoes (n = 291 cases) in multiple jurisdictions in 2009;[20,21] and
- imported frozen berries (n = 35 cases) in multiple jurisdictions in 2015.[22]

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

xiii 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, Northern Territory, Western Australia and South Australia.

xiv Hepatitis A case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_hepa.htm.

xv CDNA national guidelines for public health units. Hepatitis A: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-hepa.htm.

Epidemiology of HAV in Australia, 2017

Country of acquisition

While the number of overseas acquired HAV infections declined slightly in 2017, the annual count of Australian-acquired cases in 2017 (n = 121) was almost three times the five-year historical mean (n = 41) (Figure 8). Australian-acquired cases in 2017 exceeded the number of overseas-acquired cases for the first time since 2009, during which there was a HAV outbreak associated with the consumption of semi-dried tomatoes.[20,21]

HAV cases acquired in Australia (n = 121)

- Cases acquired in Australia were most common in males (n = 99; 82%).
- Among males, cases were most common among those aged 20–49 years (n = 77; 78%). Among females, cases were most common among those aged 10–14 years (n = 5; 23%) and 40–44 years (n = 3; 14%).
- Cases were reported in residents of Victoria (n = 53), New South Wales (n = 37), South Australia (n = 17), Queensland (n = 10), Australian Capital Territory (n = 2) and Western Australia (n = 2).
- Five cases were reported amongst Aboriginal and/or Torres Strait Islander people.

HAV cases acquired overseas (n = 95)

- Over half of the overseas-acquired cases were male (n = 60; 63%).
- The most frequently reported age groups affected were 20–34 years (n = 42; 44%).
- HAV infection was most commonly acquired in India (Table 7).

HAV outbreaks

Foodborne outbreak

Eleven cases of HAV in Australia, including ten confirmed cases and one probable case due to secondary transmission, were part of a multi-jurisdictional outbreak linked to consumption of imported frozen mixed berries (refer to *Foodborne Outbreaks* section).

Figure 8: HAV notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2017

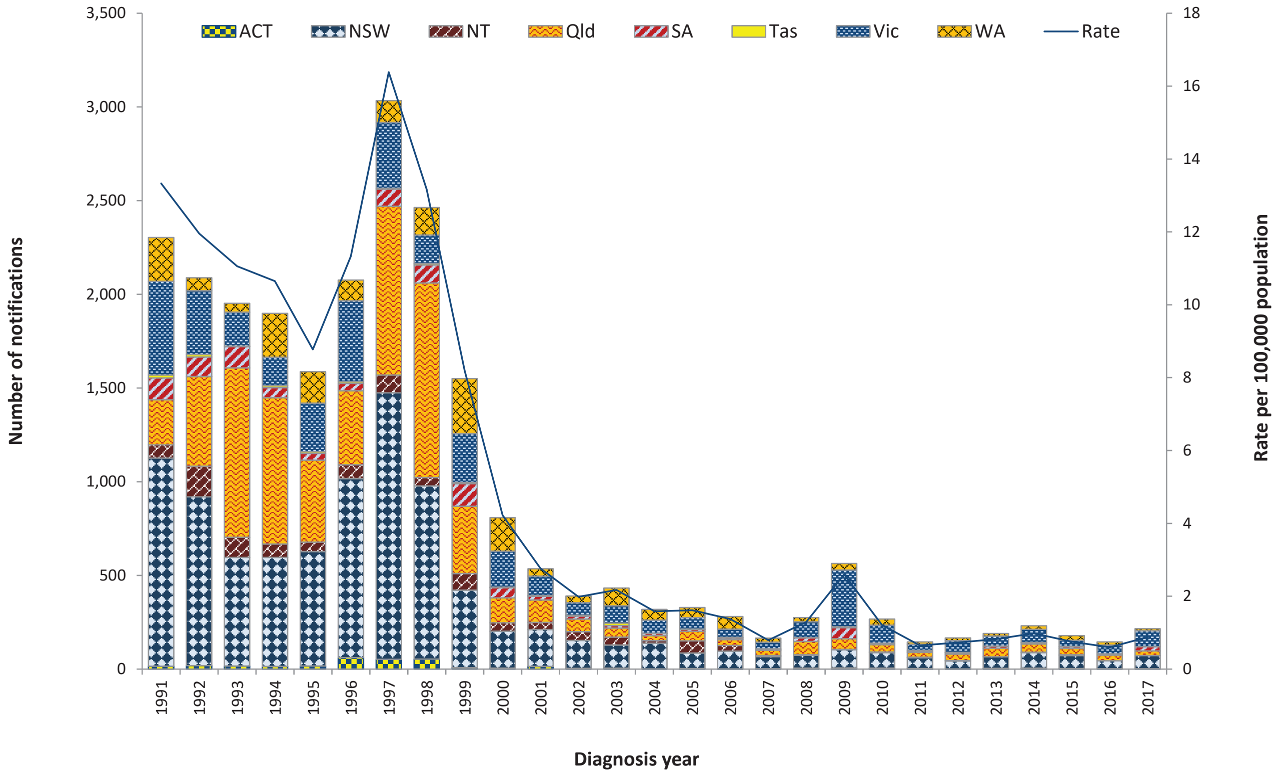
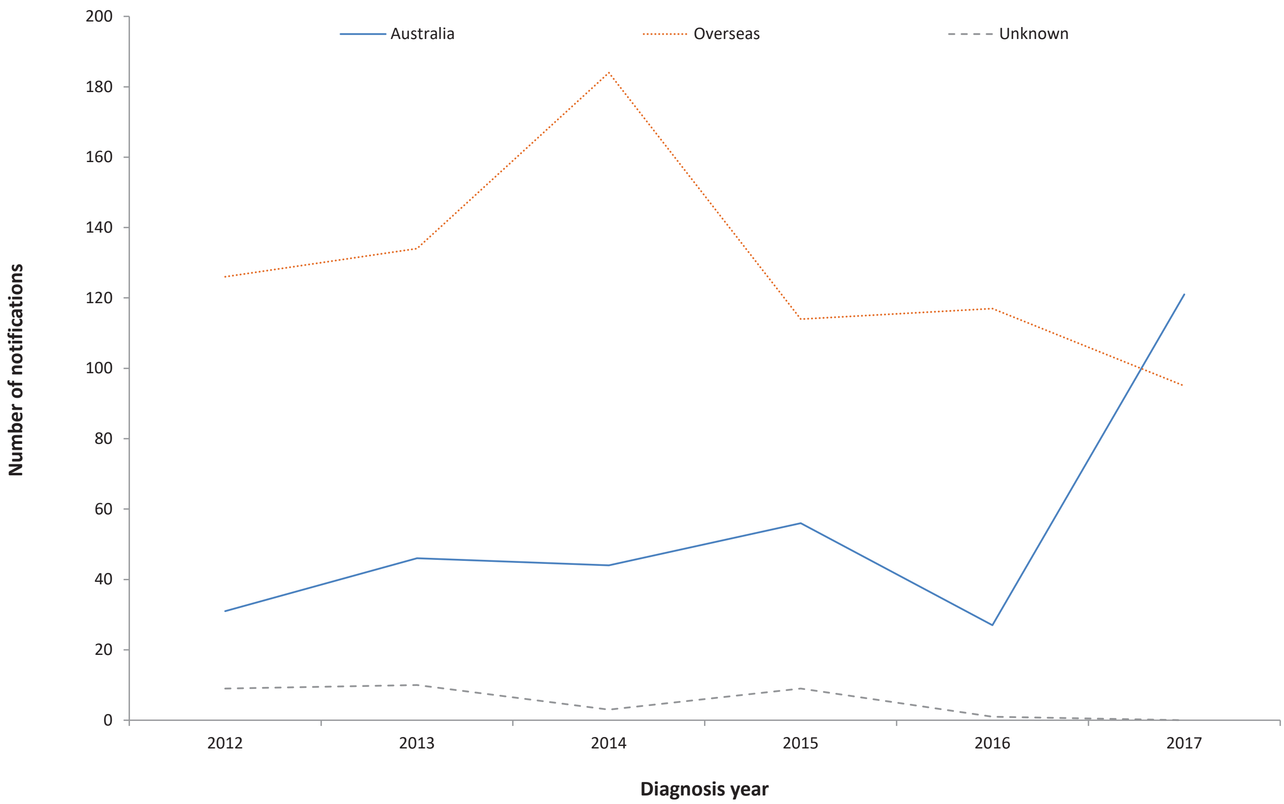


Table 6: Summary of HAV notifications in Australia, 2017

Category	Value
Number of notifications	216
Rate	0.9 cases per 100,000 population
Jurisdiction with the highest number of notifications	Victoria (n = 84; 39%)
Hospitalisations (% of all cases)	66 (31%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	5 (2%)
Foodborne outbreaks	1 (n = 11 cases) linked to imported frozen berries (Refer to Foodborne Outbreaks section)

a Indigenous status was not known for 15 cases (7%).

Figure 9: HAV notifications in Australia by place of acquisition, 2012–2017



Outbreak amongst men who have sex with men

A national investigation was initiated following an increase in HAV cases with no history of overseas travel. Cases who had spent some of their acquisition period (15 to 50 days prior to onset of illness) in Australia and 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.[23–25]

Table 7: Top three countries of acquisition for overseas acquired HAV cases in Australia, 2017

Country of acquisition	Number of notifications, 2017	Proportion of overseas acquired cases, 2017[a]	Mean 2012–2016
India	17	18%	21
Pakistan	5	6%	12
Philippines	5	6%	12

a Excluding cases known to be overseas acquired without a single identified country of acquisition (n = 8).

Ninety-three cases were linked to the outbreak in 2017, with cases reported in Victoria (n = 37), New South Wales (n = 36), South Australia (n = 14), Queensland (n = 5) and the Australian Capital Territory (n = 1). The median age of cases was 36 years (range 10–85 years). Almost all cases were male (n = 89; 98%), and during case follow up over two thirds identified as men who have sex with men (MSM) (n = 63; 69%). One fifth of cases reported overseas travel (n = 18; 19%) including to countries experiencing outbreaks amongst MSM. In response to the outbreak, affected jurisdictions implemented public health messaging and vaccination campaigns targeted to specific at risk groups (including MSM). The outbreak continued into 2018. ■

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.[26] HEV has been found in pig herds in Australia.[27]

Surveillance data includes confirmed cases only. A confirmed case requires either laboratory definitive evidence or laboratory suggestive and clinical evidence of HEV infection.[xvi] 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 owing to a local outbreak (Figure 10).

Previous outbreaks in Australia

- A foodborne outbreak in NSW, following the consumption of pork liver pâté in 2014 (n = 17 cases), is the only known outbreak of HEV to have occurred in Australia.[26]

xvi Hepatitis E case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_hepe.htm.

Figure 10: HEV notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2017

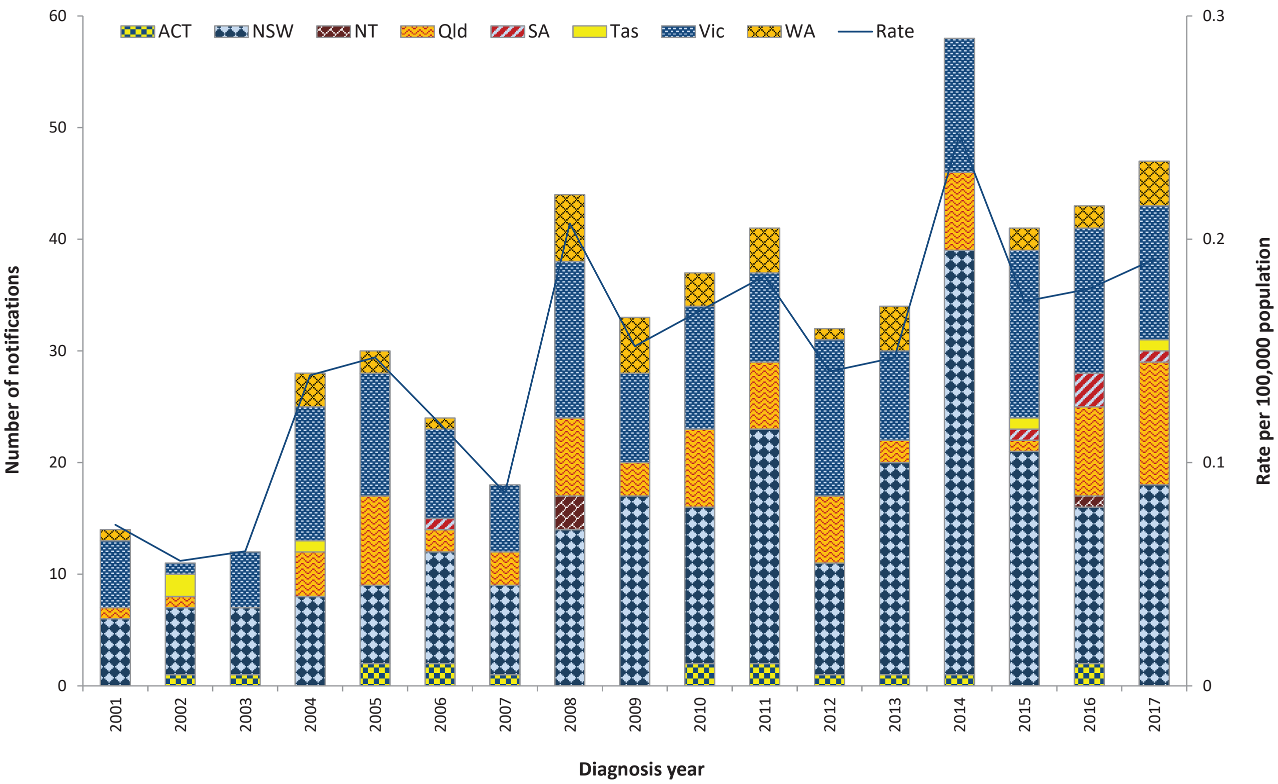
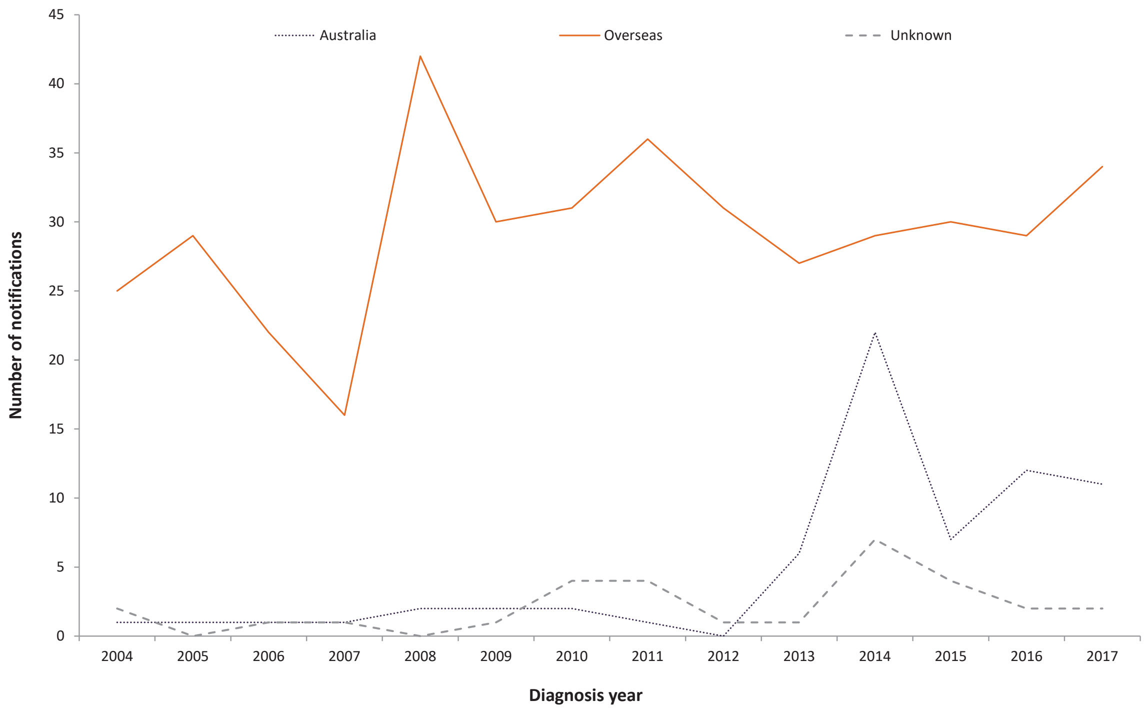


Table 8: Summary of HEV notifications in Australia, 2017

Category	Value
Number of notifications	47
Rate	0.2 cases per 100,000 population
Jurisdiction with the highest number of notifications	New South Wales (n = 18, 38%)
Hospitalisations (% of all cases)	24 (51%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	0
Foodborne outbreaks	0

a Excluding cases with Indigenous status not known (n = 4; 9%).

Figure 11: HEV notifications in Australia by place of acquisition, 2004–2017



Epidemiology of HEV in Australia, 2017

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 increasing number of Australian-acquired infections have been reported (Figure 11). The extent to which this has been influenced by changes in testing practices is unclear.

HEV cases acquired overseas (n = 34)

- As seen in previous years, HEV infection was most commonly acquired in India (Table 9).
- The majority of cases acquired overseas were male (n = 23; 68%), with a median age of 35 years (range 16–73 years).

HEV cases acquired in Australia (n = 11)

- Cases were residents of New South Wales (n = 4), Queensland (n = 4) and Victoria (n = 3).
- While the source of infection was not

Table 9: Top three countries of acquisition for overseas acquired HEV cases in Australia, 2017 (n = 31)

Country of acquisition	Number of notifications, 2017	Proportion of overseas acquired cases, 2017[a]	Mean 2012–2016
India	12	39%	14
China	4	13%	2
Bangladesh	4	13%	2

a Excluding cases known to be overseas acquired without an identified country of acquisition (n = 3).

identified for these cases, four of the nine cases with food consumption data available reportedly consumed pork products during their respective incubation periods.

- The majority of cases acquired in Australia were male (n = 8; 73%), and the median age was 54 years (range 33–83 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. The elderly, pregnant women and people who are immunocompromised (either by medical condition or medications) are at an increased risk of infection.[28]

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.[xvii] All notified cases are followed up by jurisdictional public health staff.[xviii]

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).

xvii Listeriosis case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_listera.htm.

xviii CDNA national guidelines for public health units. Listeriosis: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-listeriosis.htm.

Figure 12: Listeriosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1994–2017

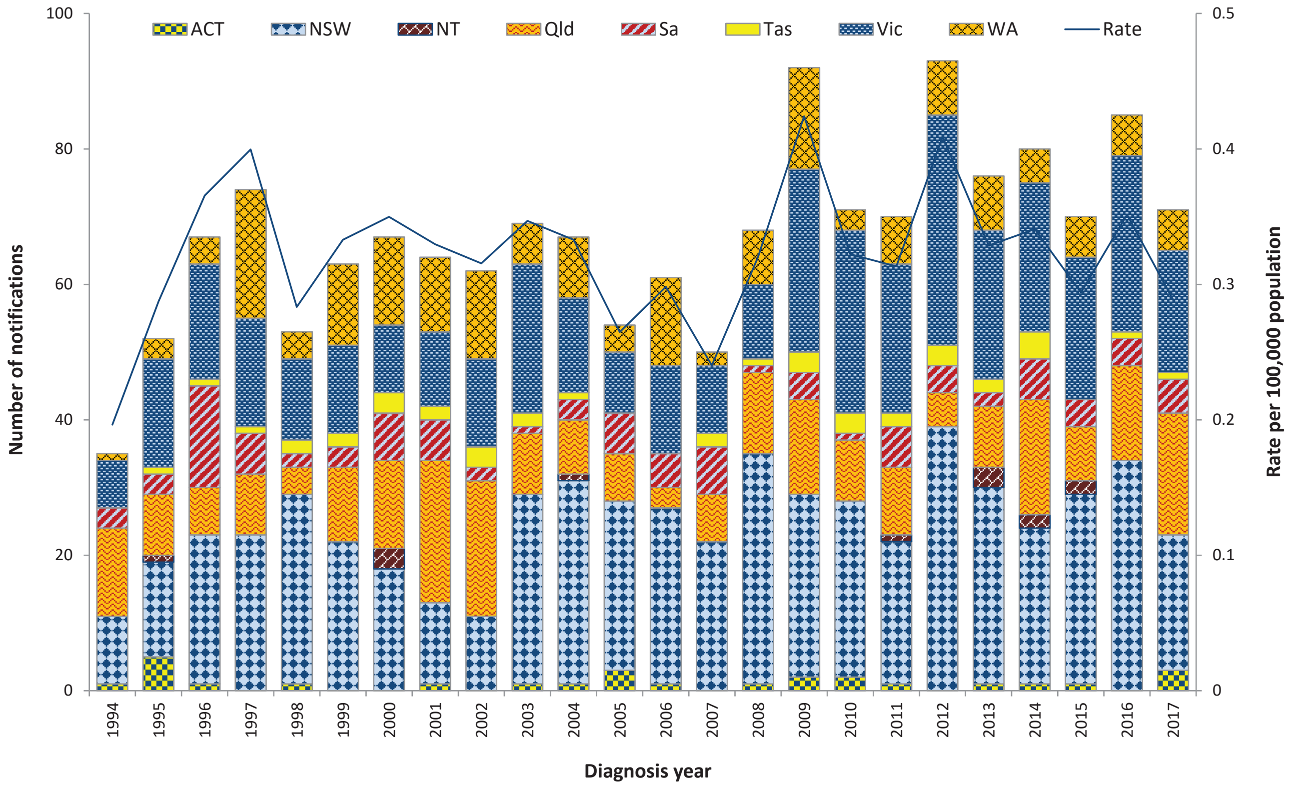


Table 10: Summary of listeriosis notifications in Australia, 2017

Category	Value
Number of notifications	71 including: 49 non-perinatal cases and 22 perinatal cases
Rate	0.3 cases per 100,000 population
Hospitalisation (% of all cases)	71 (100%)
Cases in Aboriginal and/or Torres Strait Islanders (% of all cases)	1 (1%)
Jurisdiction with the highest number of notifications	New South Wales (n = 20, 28%)
Foodborne outbreaks	1 (n = 3 cases)
Food implicated in outbreak	Not identified

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;
- cooked chopped chicken (n = 3 cases) in Western Australia in 2009;
- chicken wraps (n = 36 cases) in multiple jurisdictions in 2009;
- melons (n = 9 cases) in multiple jurisdictions in 2010;
- cold meat (n = 6 cases) in Victoria in 2010;
- smoked salmon (suspected) (n = 3 cases) in multiple jurisdictions in 2012;
- soft cheese (brie/camembert) (n = 34 cases) in multiple jurisdictions in 2012–2013;[29]
- profiteroles (n = 3 cases) in New South Wales in 2013;
- pre-prepared frozen meals (n = 3 cases) in Western Australia in 2013; and
- deli meats (n = 8) in multiple jurisdictions in 2016.[5]

Epidemiology of listeriosis in Australia, 2017

MLST typing

Multi-locus sequence typing (MLST) is determined *in silico* from whole genome sequencing data. A total of 20 different MLST types were reported in 2017. The most common type identified was MLST 1 (Table 11).

Table 11: Listeriosis cases in Australia by MLST typing, 2017[a]

MLST	No. cases	Proportion
1	14	22%
2	4	6%
3	9	14%
4	1	2%
7	4	6%
8	2	3%
9	3	5%
14	4	6%
18	1	2%
37	1	2%
87	3	5%
91	4	6%
120	1	2%
121	1	2%
155	1	2%
204	4	6%
299	2	3%
321	1	2%
399	1	2%
997	1	2%
Total	**62**	**100%**

a Excluding cases with isolates not typed (n = 3), and maternal/foetal infection counted once only (n = 6). Data taken from NELSS.

Table 12: Non-perinatal listeriosis cases by clinical presentation in Australia, 2017[a]

Nature of the illness	No. cases	Proportion of all cases (%)	Deaths
Septicaemia	36	73%	7
Meningitis and septicaemia	1	2%	0
Meningitis	3	6%	0
Other[b]	7	14%	0
Unknown	2	4%	0
Total	**49**	**100%**	**7**

a Data taken from NELSS.

b 'Other' included bacteraemia, chest pain, gastroenteritis, hip swelling, right flank pain and neck stiffness with fever.

Table 13: Immunocompromising conditions for non-perinatal listeriosis cases in Australia, 2017 (n = 49)

Condition	No. cases	Proportion of all cases (%)
Cancer	28	57%
Diabetes	16	33%
Heart disease	13	27%
Chronic lung disease (excluding asthma)	10	20%
Renal disease not requiring dialysis	8	16%
Liver disease	7	14%
Blood disorder	4	8%
Renal / kidney disease requiring dialysis	3	6%
Rheumatological condition	2	4%
No immunocompromising conditions	5	10%

Perinatal cases (n = 22)

- Of the 22 perinatal cases notified, 12 cases were pregnant women and ten were neonates (infants less than four weeks of age). Of these 22 cases, nine mother/neonate pairs were notified (representing 18 notifications), three notifications were in a mother only, and one notification was in a neonate only.
- The outcome of the 12 pregnancies was miscarriage (n = 1),[xix] neonatal death (n = 6),[xx] and neonatal survival (n = 5). None of the pregnant women died. Illnesses reported for the mother (available for ten cases) included bacteraemia/sepsis (n = 4), amnionitis (n = 1), non-specific 'flu-like' symptoms (n = 4) and fever (n = 1).

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

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

Non-perinatal cases (n = 49)

- 53% of the cases were female (n = 26).
- The majority of cases (n = 32; 65%) were aged over 65 years, with 31% (n = 15) aged over 80 years.
- Septicaemia was the most common clinical presentation (Table 12).
- Forty-two cases (86%) had at least one illness/condition known to increase their risk of listeriosis infection, with cancer

and diabetes most commonly reported (Table 13).

- Of the five cases with no known comorbidities, none reported taking medications including corticosteroids, cyclosporine or other immunosuppressive drugs, in the four weeks prior to illness. A single case reported taking gastric acid medications in their incubation period.
- Seven cases died, all of whom had septicaemia. Three deaths were attributed specifically to listeriosis. ■

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. Foods sources associated with *Salmonella* infection in Australia include raw and undercooked foods of animal origin, particularly eggs and poultry, and fresh produce.[30] 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.[xxi] Note that paratyphoid and typhoid fever infections are reportedly separately (refer to *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 significantly since national notification began in 1991 (Figure 13).
- A marked increase was observed across most jurisdictions in 2014 onwards. This is due, at least in part, to the increase in PCR testing as a method of laboratory diagnosis (refer to OzFoodNet 2016 Annual Report).[5]
- A slight decline in the notification rate was observed in 2017 compared with 2015 and 2016.

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.[31,32] (Refer to *Foodborne outbreak* 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 Banh mi rolls (n = 213 cases) in Victoria in 2003;
- dips served at a Turkish restaurant (n = 442 cases) in Victoria in 2005;
- pork or chicken and salad rolls made with raw-egg mayonnaise (n = 319 cases) in New South Wales in 2007;
- chicken (n = 391 cases) in multiple jurisdictions in 2012;
- potato salad containing raw eggs (n = 350 cases) in Queensland in 2013;
- 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[33] and mung bean sprouts (n = 419 cases) in multiple jurisdictions in 2016;[5]
- *S.* Litchfield associated with papaya (n = 26 cases) in multiple jurisdictions in 2006;[34]
- *S.* Anatum associated with bagged salads (n = 311 cases) in multiple jurisdictions in 2016;[5] and
- *S.* Hvittingfoss associated with rockmelons (n = 144 cases) in multiple jurisdictions in 2016.[5]

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xxi Salmonellosis case definition: https://www1.health.gov.au/internet/main/publishing.nsf/content/cda-surveil-nndss-casedefs-cd_salmon.htm

Notable non-foodborne outbreaks reported in Australia include:

- *S.* Paratyphi B biovar Java associated with tropical fish aquariums in 2003–2004;[35]
- *S.* Paratyphi B biovar Java associated with playground sand in New South Wales in 2007–2009;[36] and
- *S.* Litchfield associated with a Northern Territory car rally in 2009.[37]

Despite the number of salmonellosis outbreaks reported, they account for only a small proportion of salmonellosis cases notified annually.

Epidemiology of salmonellosis in Australia, 2017

Consistent with previous years, notifications were significantly higher in children aged less than five years when compared with all other age groups. For all age groups over 15 years, slightly higher rates were reported in females than in males (Figure 14). Approximately two-thirds of infections occurred in summer and autumn with the highest monthly count reported in March (Figure 15).

Serotyping

Serotyping information was available for 90% (n = 14,752) of salmonellosis notifications in 2017 with a total of 237 different serotypes identified. S. Typhimurium was the most common serotype identified with a slightly lower number of cases in 2017 (n = 5,914) compared to the five-year historical mean (n = 6,366). The five most commonly identified serotypes are shown in Table 16; combined, these account for 58% of all cases with serotyping performed.

Salmonella Typhimurium

With the exception of the Northern Territory and Tasmania, *S.* Typhimurium was the most common serotype notified in each jurisdiction in 2017 with the highest notification rate reported in Western Australia (Table 17). *S.* Typhimurium isolates routinely undergo the molecular based further typing method of multiple-locus variable number tandem repeat analysis (MLVA).[xxii] In 2017, a total of 855 distinct MLVA profiles were identified, with 666 of these accounting for fewer than five cases each over the year. While in Western Australia, the Australian Capital Territory and Tasmania a single MLVA profile accounted for approximately a third of cases, for the remaining jurisdictions the most common MLVA type accounted for less than 10% of cases (Table 17). Refer to the Outbreak section for details of *S.* Typhimurium outbreaks.

Salmonella Enteritidis

S. Enteritidis is a globally important *Salmonella* serotype that can infect the internal contents of eggs, but is not endemic in Australian egg layer flocks.[38] For this reason, a travel history is sought from all notified cases, and cases who have not travelled outside Australia are further investigated to identify the likely source of infection.

In 2017, a total of 851 *S.* Enteritidis cases were notified. While this was lower than 2016 (n = 1,019) it was in line with annual notifications from 2012–2015. In accordance with previous years, the majority of cases with a known travel history reported overseas travel within their incubation period (n = 651; 86%), with approximately half reporting travel to Indonesia (n = 356; 47%). This may reflect travel practices rather than an increased risk.

S. Enteritidis acquired in Australia

S. Enteritidis infections acquired in Australia (n = 103) were most commonly reported in Queensland (n = 47), followed by New South Wales (n = 27). Three foodborne outbreaks were identified in 2017, including two outbreaks involving passengers on a cruise ship operated by the same company in December 2016 and December 2017. Refer to the *Foodborne outbreaks* section for further information. For the remaining cases, no common exposures were identified. ■

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

Figure 13: Salmonellosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 1991–2017

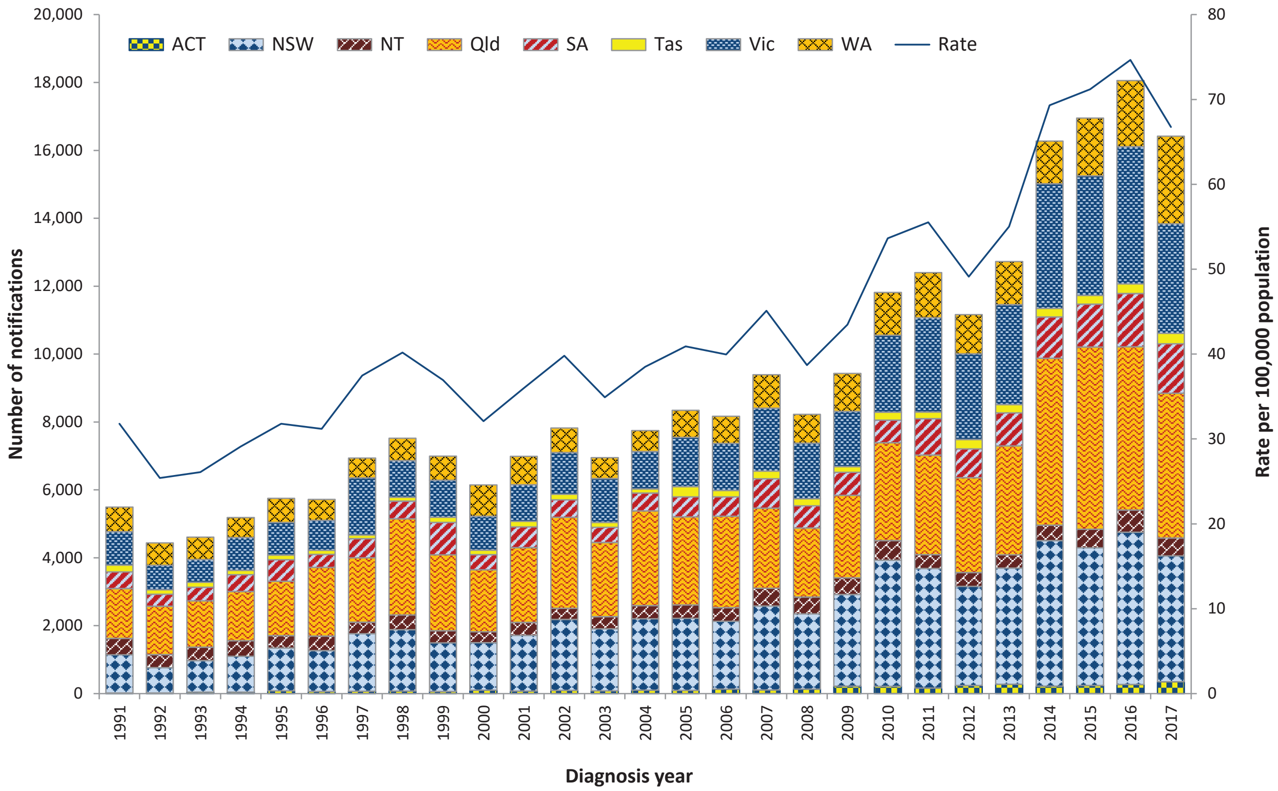


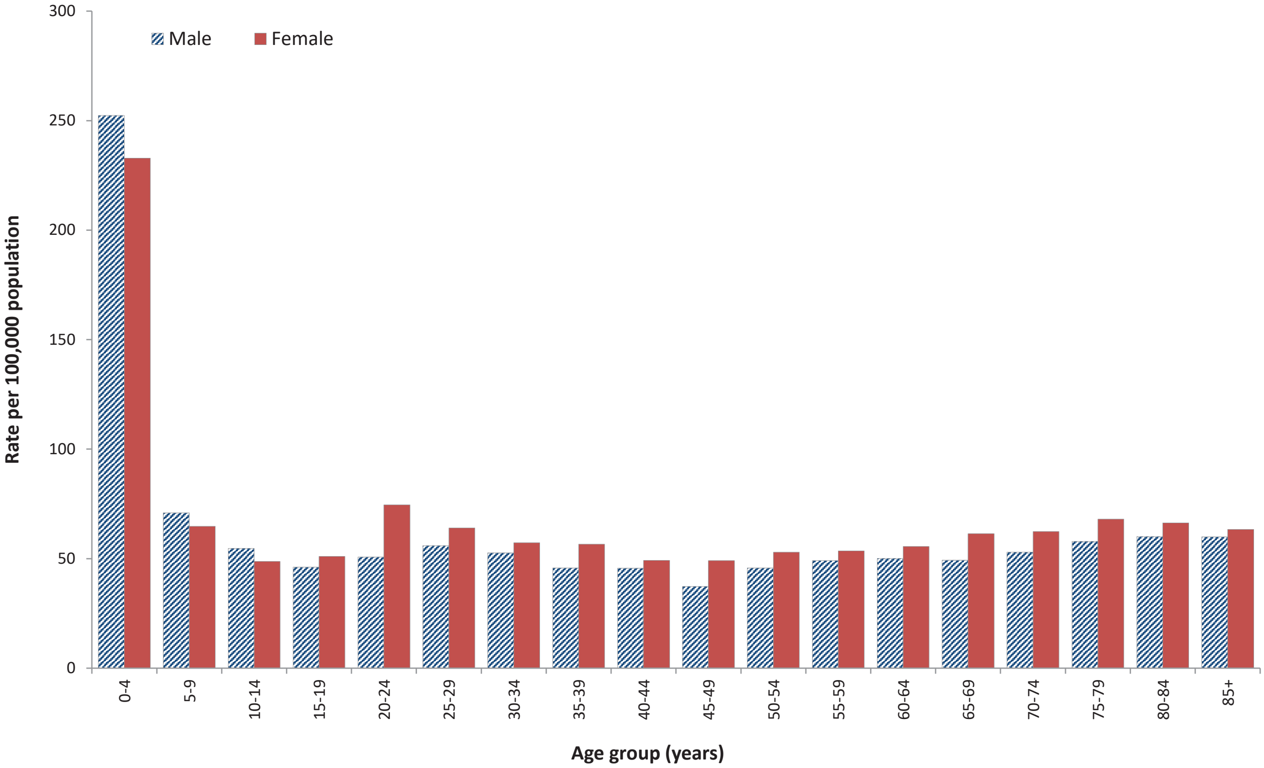
Table 14: Summary of salmonellosis notifications in Australia, 2017

Category	Value
Number of notifications	16,416
Rate	66.7 cases per 100,000 population
Jurisdiction with the highest number of notifications	Queensland (n = 4,259, 26%)
Foodborne outbreaks	102
Foods implicated in outbreaks	Most commonly eggs (n = 48 outbreaks) (Refer to Foodborne Outbreaks section)

Table 15: Groups with the highest salmonellosis notification rate in Australia, 2017

Category	Group most affected	Rate per 100,000 population	Number (% of all cases)
Age group (years)	0–4	242.3	3,838 (23%)
Sex	Females	68.7	8,528 (52%)
Jurisdiction	Northern Territory	215.4	658 (3%)

Figure 14: Salmonellosis notification rate per 100,000 population in Australia by age group and sex,[a] 2017



a Excluding cases with sex not defined (n = 18) and cases with unknown age (n = 1).

Figure 15: Salmonellosis notifications in Australia by month, and five-year historical mean, 2017

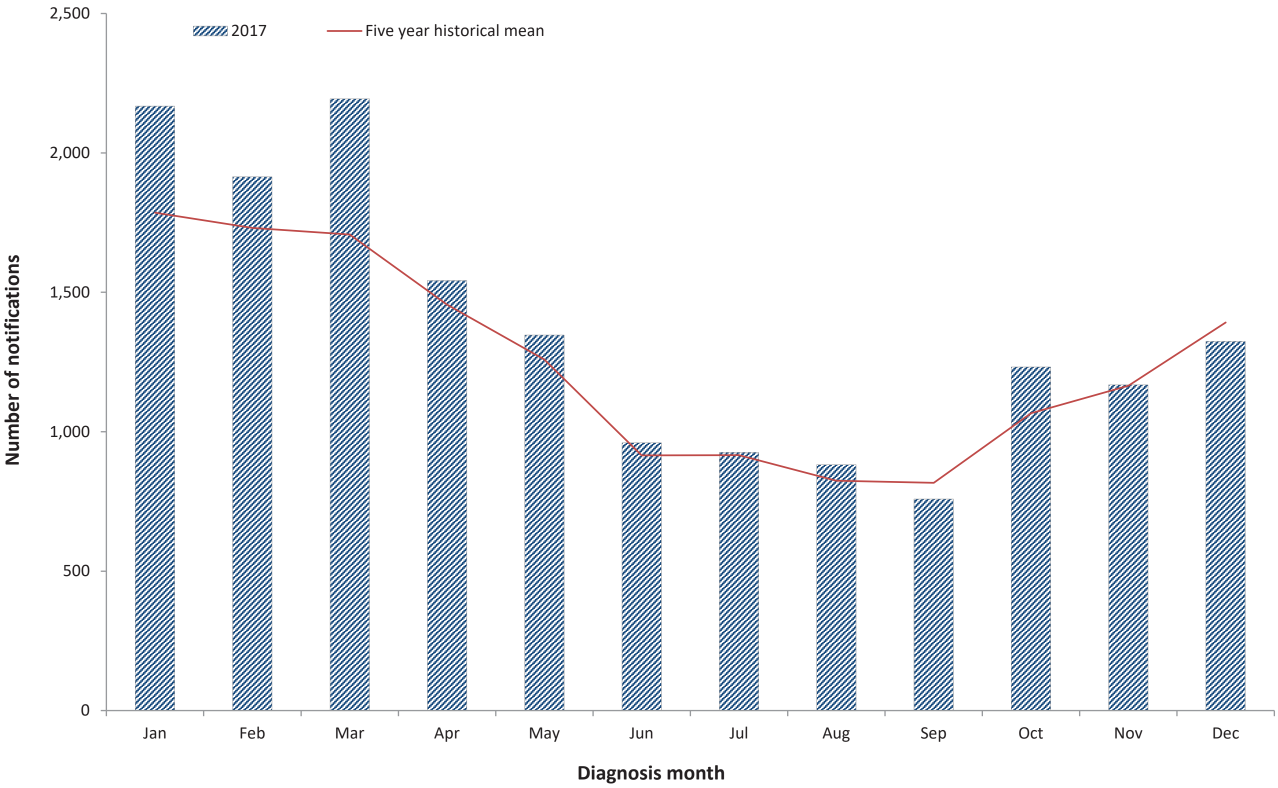


Table 16: Top five *Salmonella* serotypes notified in Australia, 2017

Salmonella serotype	No. 2017	% of all serotypes	Mean 2012–2016
S. Typhimurium	5,914	40%	6,366
S. Enteritidis	851	6%	869
S. Virchow	751	5%	659
S. Saintpaul	632	4%	600
S. Paratyphi B biovar Java	408	3%	322

Table 17: *Salmonella* Typhimurium notifications by jurisdiction and most common MLVA type[a] in Australia, 2017 (n = 5,703)

Jurisdiction[b]	Annual count 2017	Rate per 100,000 population	Number of MLVA types identified	Most common MLVA		
				MLVA type	Annual count	% of MLVA
WA	1,438	55.8	216	03-17-09-12-523	610	42%
ACT	226	54.9	42	03-17-09-12-523	71	35%
SA	827	48.0	197	03-14-11-08-523 and 03-24-11-10-523	73[c]	9%
Vic.	1,472	23.3	330	03-09-09-14-523 and 03-22-13-11-523	77[c]	5%
NT	38	15.4	N/A[d]	N/A[d]	N/A[d]	N/A[d]
NSW	1,182	15.0	323	03-17-09-11-523	43	4%
Tas.	74	14.2	30	03-15-11-10-523	21	28%
Qld	657	13.3	224	03-12-10-10-524	29	4%
Total	**5,914**	**24.0**	**855**	**03-17-09-12-523**	**767**	**13%**

a Excluding cases where MLVA type not available (n = 211).

b Jurisdictions are ordered by 2017 rate per 100,000 population. WA: Western Australia; ACT: Australian Capital Territory; SA: South Australia; Vic.: Victoria; NT: Northern Territory; NSW: New South Wales; Tas.: Tasmania; Qld: Queensland.

c Count is the same for both MLVAs (equal numbers reported for most common MLVA).

d Not reported as MLVA type unavailable for the majority of Northern Territory cases (n = 30; 79%).

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. Occasionally 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.[39,40]

Surveillance data includes confirmed cases only. A confirmed case requires laboratory definitive evidence of *Shigella*.[xxiii] The ipaH gene is the target of all current nucleic acid tests for *Shigella*. However, the ipaH gene is common to *Shigella* species and enteroinvasive *Escherichia coli* (EIEC). Since 2014, when PCR testing was introduced, jurisdictions have classified cases PCR positive cases differently. Victoria, Northern Territory and Tasmania include cases found to be positive on PCR alone as confirmed cases in the surveillance data, whereas only cases confirmed by culture are included in the Australian Capital Territory, New South Wales, Queensland, South Australia and Western Australia.

Overall trend

- Except for peaks in the number of notifications in 2005 and 2008 (observed in multiple jurisdictions), the notification rate has remained steady between 2001 (when national notification began) and 2013 (Figure 16).
- A marked increase was observed across most jurisdictions from 2014 onwards. This is due, at least in part, to the increase in PCR testing as a method of laboratory diagnosis.
- Since the introduction and increasing use of PCR testing there has been variation in the classification and subsequent notification of cases across jurisdictions to the NNDSS. Some jurisdictions have included PCR positive cases in the absence of confirmation by culture in the surveillance data, influencing the number of notifications by jurisdiction observed in Figure 16. In New South Wales, outbreaks amongst MSM contributed to the increases observed in 2014 and 2016 (refer to NSW OzFoodNet Annual Report 2016).[41]

Previous outbreaks in Australia

In addition to non-foodborne outbreaks amongst MSM and Aboriginal and/or Torres Strait Islander communities, five 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.[42]

Epidemiology of shigellosis in Australia, 2017

Aboriginal and/or Torres Strait Islander people (n = 657)

- Indigenous status was available for 92% of cases (n = 1,601), with 41% identifying as Aboriginal and/or Torres Strait Islander (n = 657).
- The majority of cases among Aboriginal and/or Torres Strait Islander people occurred in the Northern Territory (n = 400; 61%), followed by Western Australia (n = 123; 19%) and Queensland (n = 93; 14%) (Table 19).
- While a higher burden of disease has been consistently observed amongst Aboriginal and/or Torres Strait Islander people, the

xxiii Shigellosis surveillance case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_shigel.htm.

Figure 16: Shigellosis notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2017

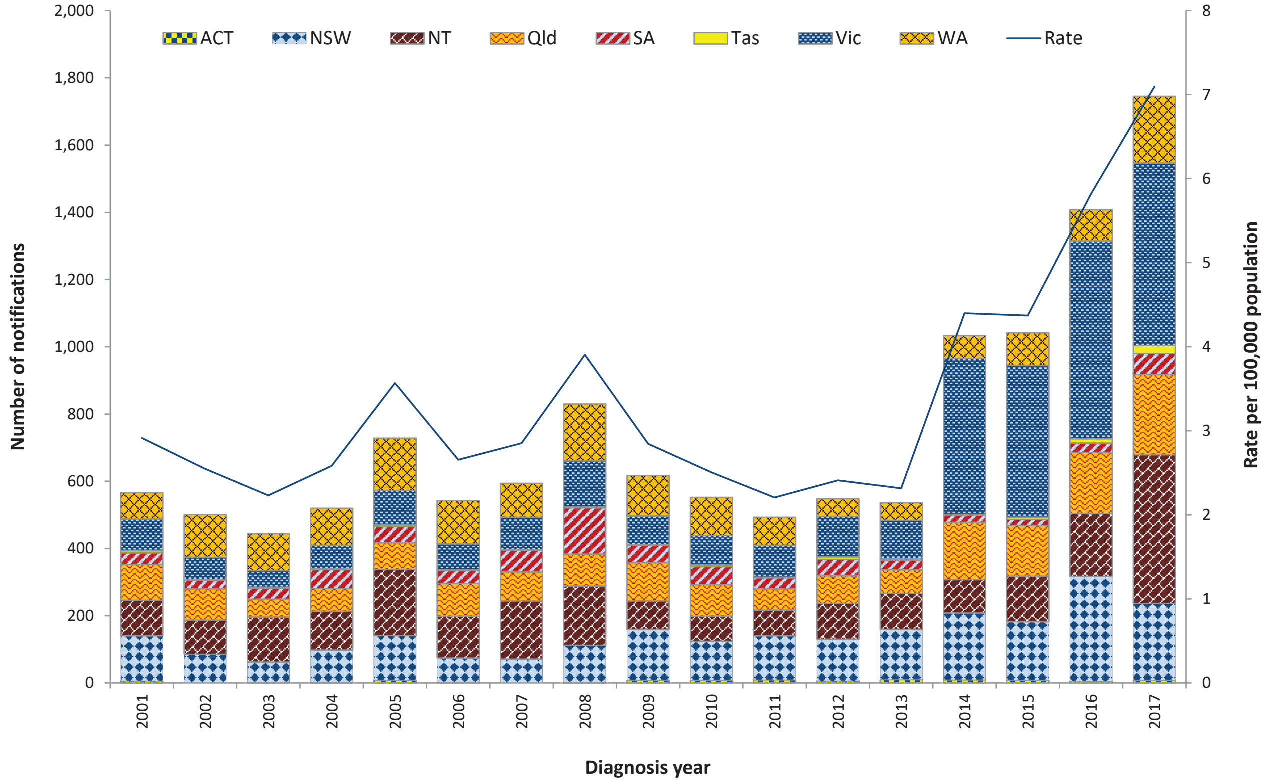


Table 18: Summary of shigellosis notifications in Australia, 2017

Category	Value
Number of notifications	1,745
Rate	7.1 cases per 100,000 population
Jurisdiction with the highest number of notifications	Victoria[a] (n = 543; 31%)
Foodborne outbreaks	2
Implicated foods and settings	Contamination of burritos by a take-away food handler, and unknown food vehicle at a restaurant

a Victoria includes PCR positive cases as confirmed cases.

notification rate in 2017 far exceeded that of non-Indigenous people (4.5 cases per 100,000 non-Indigenous people compared to 99.8 cases per 100,000 Aboriginal and/or Torres Strait Islander people) (Figure 17).

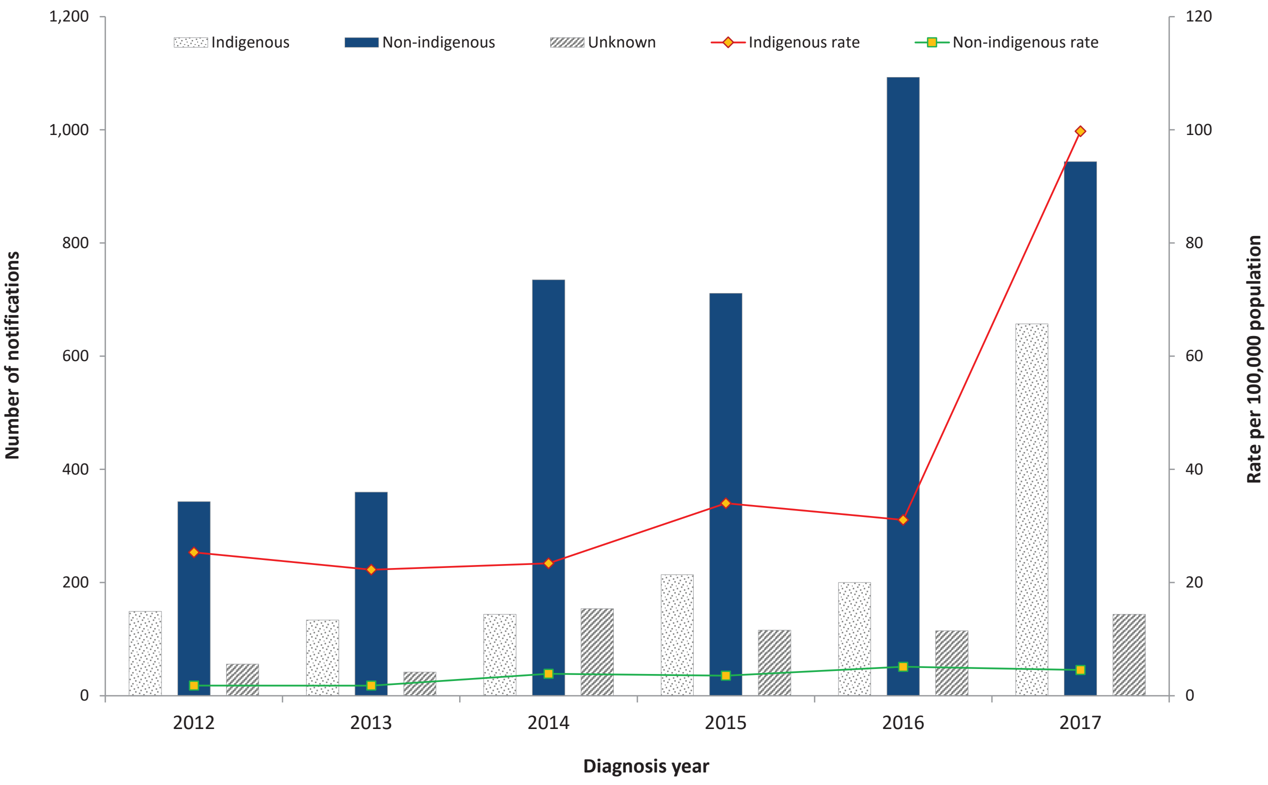
- The majority of the 532 isolates from Aboriginal and/or Torres Strait Islander people that were speciated were identified as *S. flexneri* (n = 373; 70%), with the remainder *S. sonnei* (n = 159; 30%). Where known, almost all Aboriginal and/or Torres Strait Islander *S. flexneri* cases were serotype 2b (n = 336; 90%) and almost all *S. sonnei* cases were biotype a (n = 150; 94%). Conversely, the majority of the 644 isolates from non-Indigenous people that were speciated were identified as *S. sonnei* (n = 380; 59%), with the remainder *S. flexneri* (n = 243; 38%), *S. boydii* (n = 20; 3%) and *S. dysenteriae* (n = 1; < 1%). Where known, the majority of non-Indigenous *S. sonnei* cases were biotype g (n = 278; 73%) and *S. flexneri* cases were serotype 2a (n = 107; 44%).

Table 19: Shigellosis notifications in Aboriginal and/or Torres Strait Islander people in Australia by place of residence, 2017

Jurisdiction[a]	2017 notifications	2017 rate per 100,000 people	Mean 2012–2016	% change in notifications (2017 compared to 2012–2016)
ACT	0	0.0	< 1	-100%
NSW	3	1.6	2	36%
NT	400	518.0	100	298%
Qld	93	48.1	32	192%
SA	35	99.2	7	373%
Tas	0	0.0	0	—
Vic	3	6.9	4	-17%
WA	123	141.5	23	444%
Total	**657**	**99.8**	**168**	**291%**

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

Figure 17: Shigellosis notifications and rates per 100,000 population in Australia by Indigenous status, 2012–2017[a]



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

Figure 18: *Shigella flexneri* serotype 2b notifications in Aboriginal and/or Torres Strait Islander people in Australia, by age group and sex, 2017

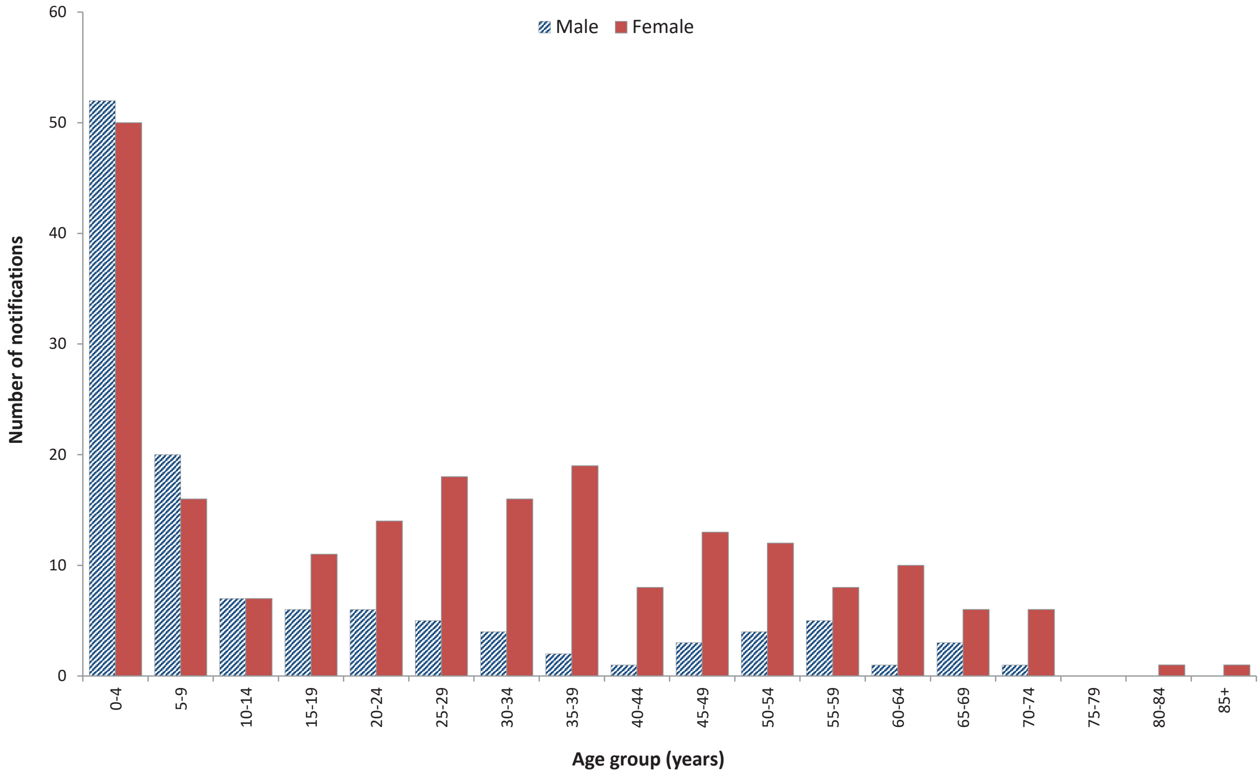
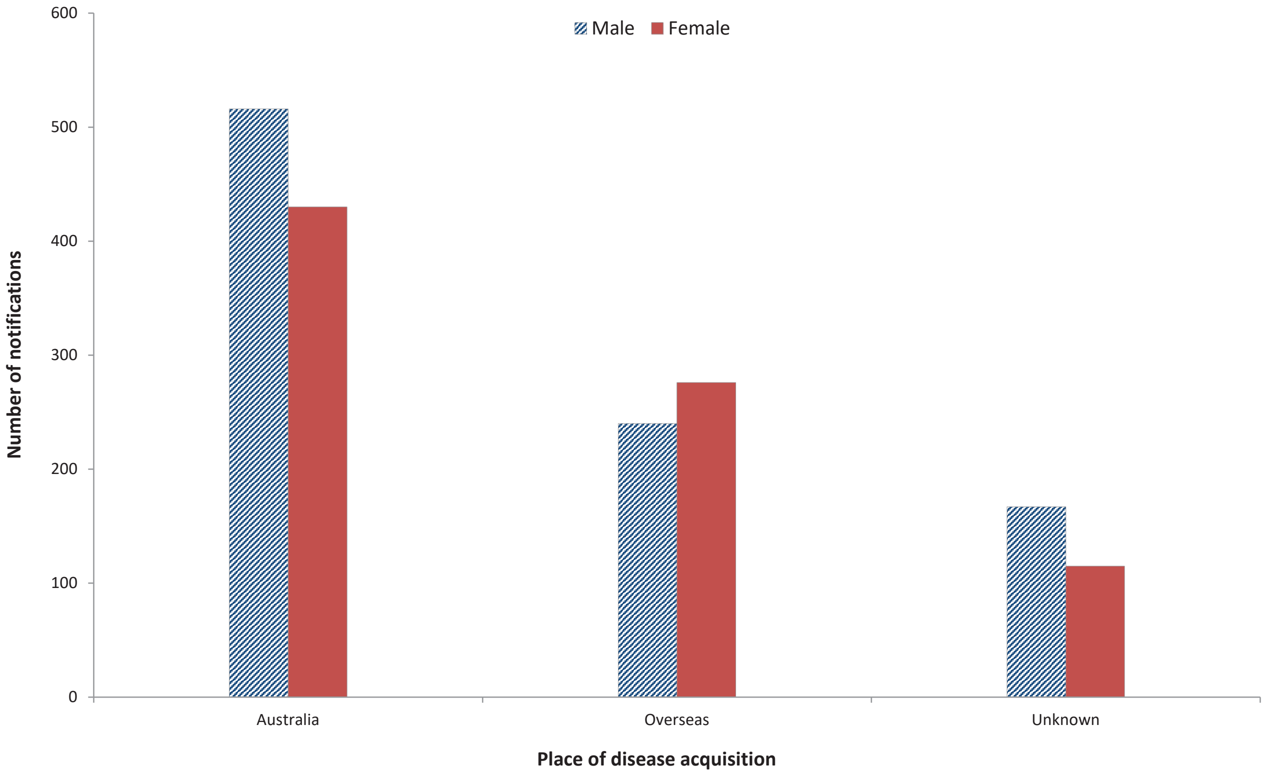


Figure 19: Shigellosis notifications in Australia by place of acquisition and sex, 2017



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

The notification rate amongst Aboriginal and/or Torres Strait Islander people more than tripled in 2017 when compared with 2016 (99.8 cases per 100,000 Aboriginal and/or Torres Strait Islander people in 2017 compared to 31.1 cases per 100,000 in 2016), largely due to an outbreak of *S. flexneri* 2b amongst Aboriginal people. *S. flexneri* 2b cases were first identified in remote areas of the Northern Territory in late 2016. Notifications were sporadic until a sharp increase was observed in May 2017. Meanwhile, in April 2017 cases were first identified in remote regions of South Australia and Western Australia. In total, 336 *S. flexneri* 2b cases were reported in Aboriginal and/or Torres Strait Islander people across the Northern Territory (n = 217), South Australia (n = 34), Western Australia (n = 75) and Queensland (n = 10) in 2017. An additional 14 *S. flexneri* 2b cases were reported in non-Indigenous residents of Western Australia, Queensland and South Australia who reported no overseas travel during their respective incubation periods. Case detection is limited by the inability to identify the species of cases diagnosed solely by PCR. A further 51 *Shigella* cases diagnosed by PCR were reported from the affected regions in South Australia. The Northern Territory estimated that 19 of the 20 unserotyped *S. flexneri* cases and 110 of the 153 untyped *Shigella* species in 2017 were related to this outbreak.[43] With the exception of a single probable foodborne outbreak affecting two cases in the Northern Territory, no other foodborne outbreaks were identified suggesting person-to-person was the most likely mode of transmission. Children less than five years of age were most commonly affected (Figure 18). For those aged over 15 years, infections were more common in females, which may reflect child rearing practices. The Northern Territory outbreak is further described in the associated surveillance report.[43] The outbreak continued into 2018.

Country of acquisition

- Information on the country of acquisition was available for 84% (n = 1,463) of cases, of which approximately two-thirds (n = 947; 65%) were acquired in Australia.
- Of the infections that were acquired in Australia, males accounted for a higher proportion of cases (n = 516; 54%) than females (n = 430; 45%). This may be associated with to male-to-male sexual transmission (Figure 19).
- Consistent with previous years, overseas-acquired cases (n = 516) were most commonly acquired in India (n = 128; 25%) and Indonesia (n = 101; 20%). ■

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 that 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 an STEC infection usually report a history of a diarrheal 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 diarrhea, 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;[xxiv] a confirmed case of HUS requires clinical evidence only.[xxv] Where STEC is isolated in the context of HUS, it is notified as both STEC and HUS.[xxvi]

Prior to 1 July 2016, the case definition required that '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 stx1 and/or stx2 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).
- 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 a sharp increase in notifications.
    - Changes to the case definition for confirmed STEC cases in 2016 and the increasing uptake of CIDT have contributed to the increase in STEC cases nationally.
- HUS is rare in Australia, with notification rates relatively stable since notification began in 1999.

xxiv Shiga toxin-producing *Escherichia coli* (STEC) case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_stec.htm.

xxv Haemolytic uraemic syndrome (HUS) case definition: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_hus.htm.

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

Previous outbreaks in Australia

Most STEC cases are sporadic in Australia though outbreaks have been reported. Risk factors identified in a national case-control study in Australia between 2003–2007 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.[44]

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 was the implicated source of an international outbreak in 2011 that included over 3,000 STEC and 800 HUS cases.[45] In Australia, however, 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 (when OzFoodNet commenced), the implicated foods in confirmed and probable STEC outbreaks reported in Australia include:

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

Non-foodborne outbreaks

Outbreaks due to contaminated tank water, person-to-person 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).

Epidemiology of STEC and HUS in Australia, 2017

STEC

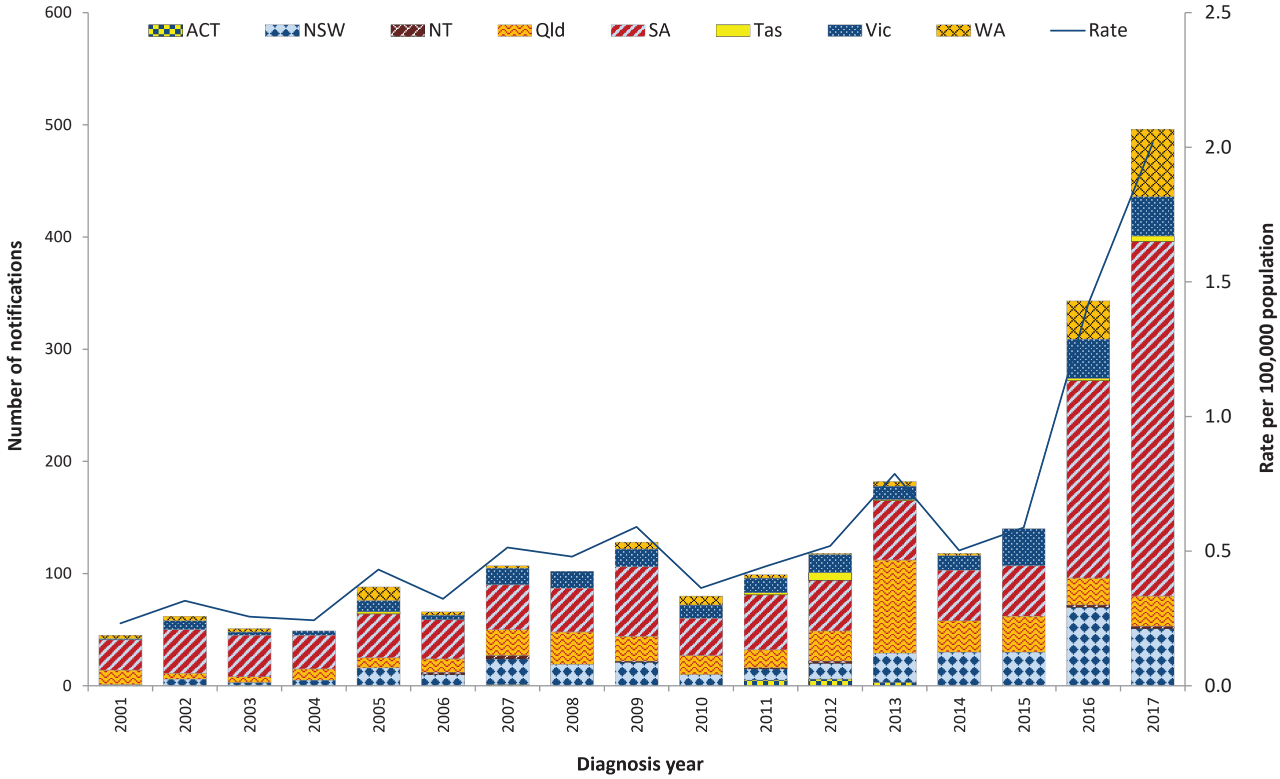
- Notifications peaked in children aged 0–4 years (n = 68; 14%), followed by those aged 50–59 years (n = 43; 9%) and were more common in females (n = 275; 55%) compared with males (n = 221; 45%) (Figure 21).
- Where known, the majority of cases (n = 380; 85%) were acquired in Australia. Of the cases known to be acquired overseas (n = 59), India was the most common country of acquisition (n = 20).
- With the exception of a single cluster in Queensland involving an index case with unknown source and two secondary cases in household contacts, no outbreaks were identified.

Table 20: Summary of STEC and HUS notifications in Australia, 2017

	STEC	HUS
Number of notifications	496	14
Rate	2.0 cases per 100,000 population	0.1 cases per 100,000 population
Jurisdiction with highest number of notifications	South Australia (n = 316; 64%)	Victoria (n = 4; 29%)
Cases in Aboriginal and/or Torres Strait Islanders[a]	19	0
Foodborne outbreaks	0	0

a Indigenous status unknown for 22 STEC cases and one HUS case.

Figure 20: STEC notifications and rate per 100,000 population in Australia by jurisdiction of residence, 2001–2017[a]

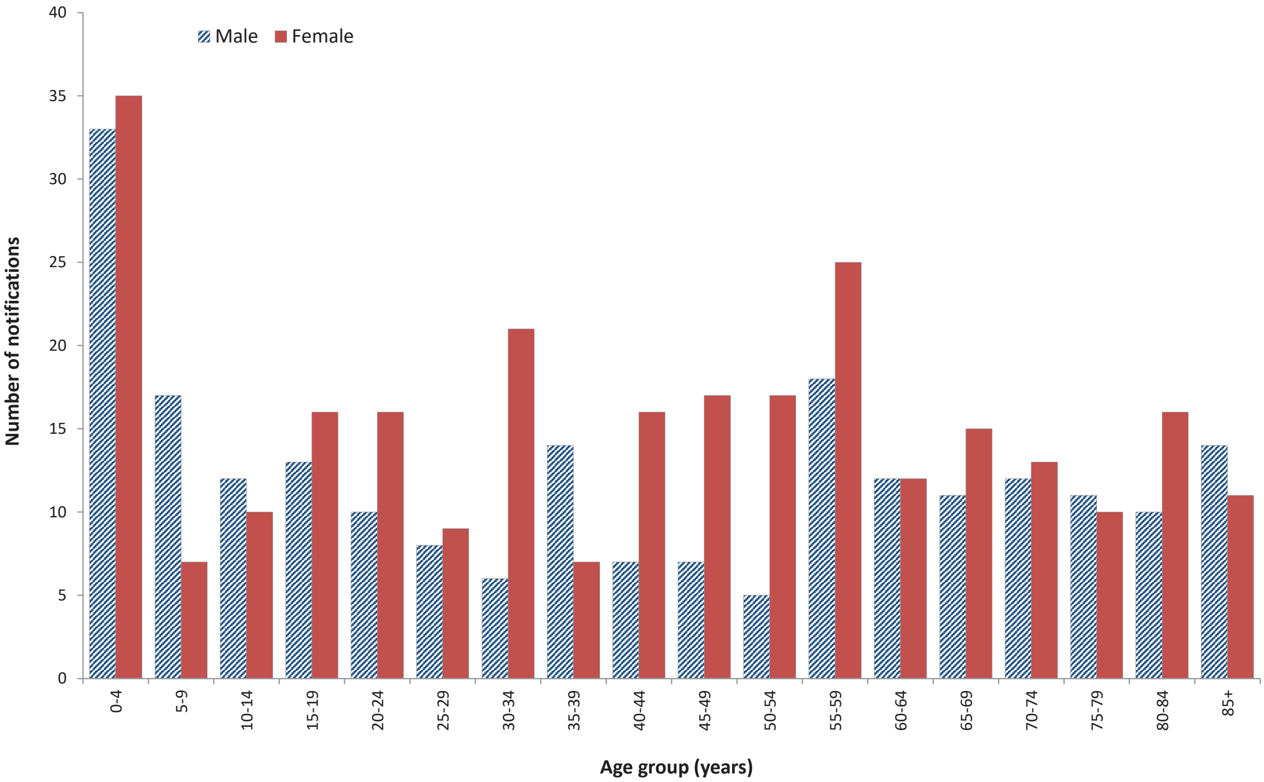


a Data includes HUS cases where an STEC organism was isolated (see above footnote).

HUS

- Consistent with previous years, HUS was most commonly reported in children aged less than five years (n = 6; 43%).
- Notifications were more common in females (n = 10) compared with males (n = 4).
- In accordance with recent years, STEC infection was identified in 50% (n = 7) of the HUS cases reported in 2017.
- Of the seven cases for whom STEC infection was not identified, two cases reported a history of a diarrheal illness while another was presumed to be non-infectious. ■

Figure 21: STEC cases in Australia by age group and sex, 2017[a]



a Excluding cases with unknown age (n = 3).

Outbreaks of gastrointestinal disease including foodborne disease outbreaks

In 2017, a total of 206 outbreaks of gastrointestinal illness caused by foodborne, animal-to-person, environmental or waterborne disease were reported by OzFoodNet sites, affecting 2,385 individuals. The majority (89%) of outbreaks were a result of foodborne and probable foodborne transmission of infection (Table 21).

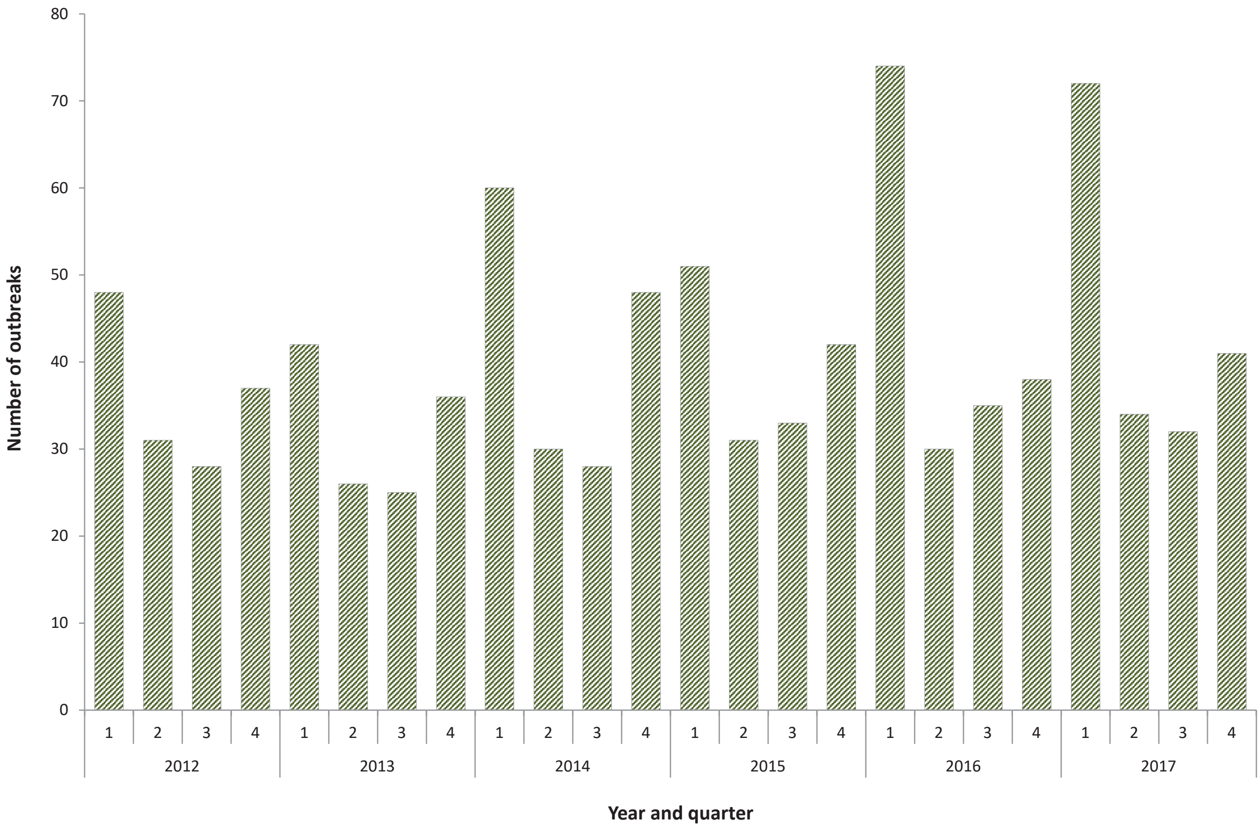
Foodborne and probable foodborne outbreaks

OzFoodNet sites reported 179 outbreaks where the consumption of food was the probable or confirmed mode of transmission (hereon referred to collectively as foodborne outbreaks). Foodborne outbreaks affected a total of 2,130 people. While the total number of outbreaks reported in 2017 was higher than the five-year historical mean (n = 155 outbreaks), fewer people were affected (Table 21). Admission to hospital was required for at least 290 people, and five deaths were reported during the outbreaks.

Victoria and Western Australia reported the highest number of foodborne outbreaks in 2017 (Table 22). Consistent with previous years, outbreaks more commonly occurred in the warmer months of January to March (Quarter 1) (Figure 22 and Figure 23).

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

Figure 22: Foodborne outbreaks in Australia by year and quarter,[a] 2012–2017



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

Table 21: Gastrointestinal disease outbreaks and ill people by transmission mode in Australia, 2017

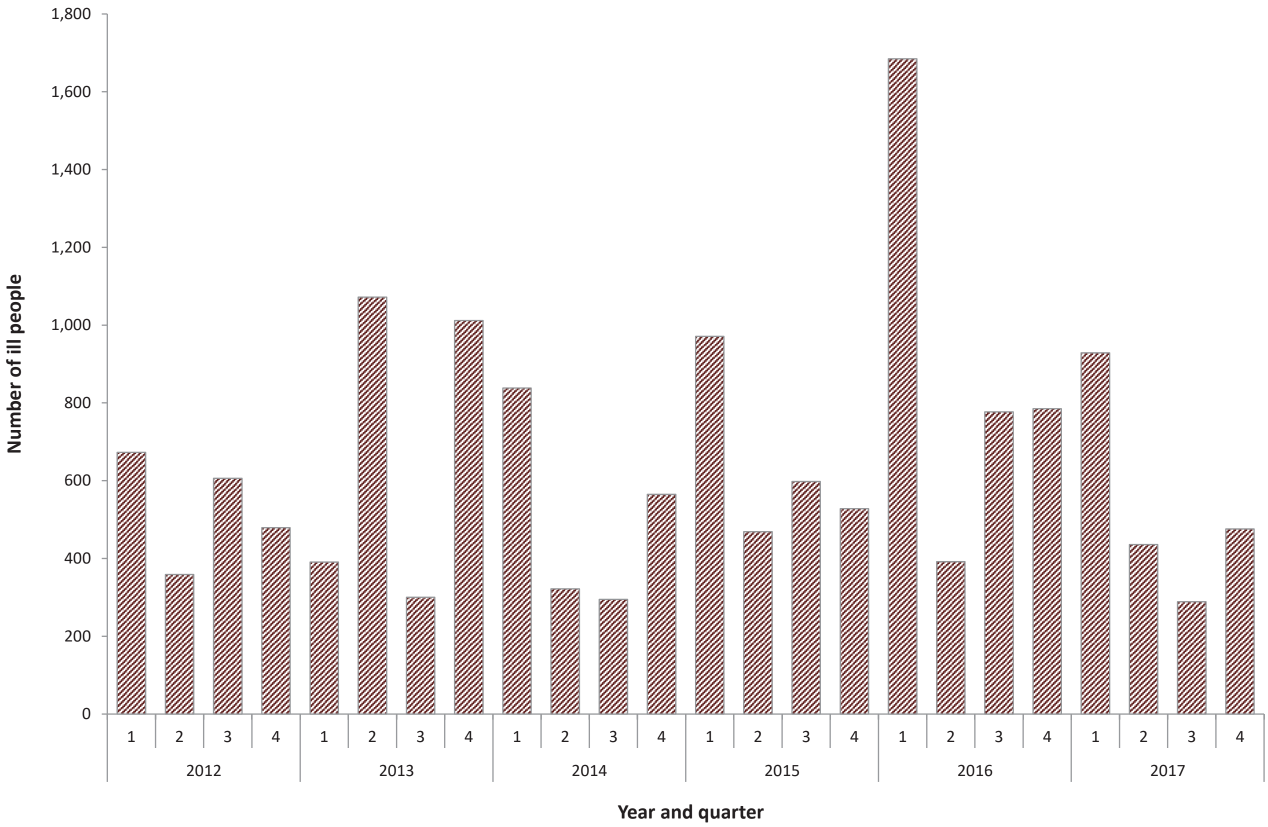
Transmission mode	Outbreaks			Ill people		
	No. 2017	Proportion	Annual mean 2012–2016	No. 2017	Proportion	Annual mean 2012–2016
Foodborne and probable foodborne	179	87%	155	2,130	89%	2,623
Environmental and probable environmental	22	11%	13	225	9%	89
Animal-to-person and probable animal-to-person	3	1%	1	14	1%	20
Waterborne and probable waterborne	2	1%	2	16	1%	29
Total	**206**	**100%**	**171**	**2,385**	**100%**	**2,762**

Table 22: Foodborne outbreaks and affected people in Australia by jurisdiction, 2017

Jurisdiction[a]	Outbreaks		Ill people			
	Number of outbreaks	Proportion	Total no.	Mean ill per outbreak	Hospitalised	Fatalities
MJOI	1	1%	11	11	5	0
ACT	8	4%	168	21	33	0
NSW	36	20%	416	36	14	0
NT	7	4%	95	14	5	0
Qld	21	12%	195	9	41	0
SA	17	9%	261	14	53	2
Tas.	5	3%	57	11	0	0
Vic.	42	23%	468	11	78	1
WA	42	23%	459	11	61	2
Total	**179**	**100%**	**2,130**	**12**	**290**	**5**

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: Number of ill people in foodborne outbreaks in Australia by year and quarter,[a] 2012–2017



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

Table 23: Foodborne outbreaks, ill people and hospitalisations in Australia by aetiology, 2017

Aetiological agent	Outbreaks		Ill people		Hospitalisations	
	No.	% of all outbreaks	No.	% of all ill	No.	% of all hospitalised
Salmonella	102	57%	1,271	60%	261	90%
Norovirus	11	6%	213	10%	9	3%
Ciguatoxin	9	5%	32	2%	5	2%
Campylobacter	6	3%	53	2%	1	< 1%
Clostridium perfringens	5	3%	39	2%	0	< 1%
Shigella	2	1%	5	< 1%	0	< 1%
Cryptosporidium	1	1%	7	< 1%	0	< 1%
Hepatitis A	1	1%	11	1%	5	2%
Listeria monocytogenes	1	1%	3	< 1%	3	1%
Vibrio albensis	1	1%	3	< 1%	1	< 1%
Unknown	40	22%	493	23%	5	2%
Total	**179**	**100%**	**2,130**	**100%**	**290**	**100%**

Table 24: Foodborne outbreaks and ill people in Australia by food commodity, 2017

Category	Outbreaks		Ill people	
	No.	% of all outbreaks	No.	% of all ill
Eggs (including raw/lightly cooked/binding agent)	49	27%	746	35%
Seafood	13	7%	78	4%
Poultry	11	6%	139	7%
Meat	9	5%	84	4%
Dairy	2	1%	9	<1%
Sauces (non-egg)	1	1%	2	<1%
Grains	1	1%	9	<1%
Produce	1	1%	11	1%
Mixed/multiple foods	23	13%	394	18%
Not attributed	69	39%	658	31%
Total	**179**	**100%**	**2,130**	**100%**

Aetiologies

Consistent with previous years, *Salmonella* was the most commonly identified foodborne pathogen, responsible for 57% (n = 102) of all outbreaks and 60% (n = 1,271) of all cases of foodborne illness reported during outbreaks in 2017 (Table 23). *S.* Typhimurium was the most commonly identified serotype, accounting for 86% (88/102) of all *Salmonella* outbreaks reported in 2017, of which 56 different causative MLVA profiles were identified.

Food commodity

A food vehicle was identified in 61% (n = 110) of foodborne outbreaks in 2017. Outbreaks were categorised as being attributable to selected broad food categories if a single contaminated ingredient was identified or all of the identified ingredients belonged to a single food category. A single food commodity was identified for 49% (n = 87) of foodborne outbreaks in 2017. The most commonly identified commodity was eggs (n = 49; 27%), followed by seafood (n = 13; 7%) (Table 24 and Table 25).

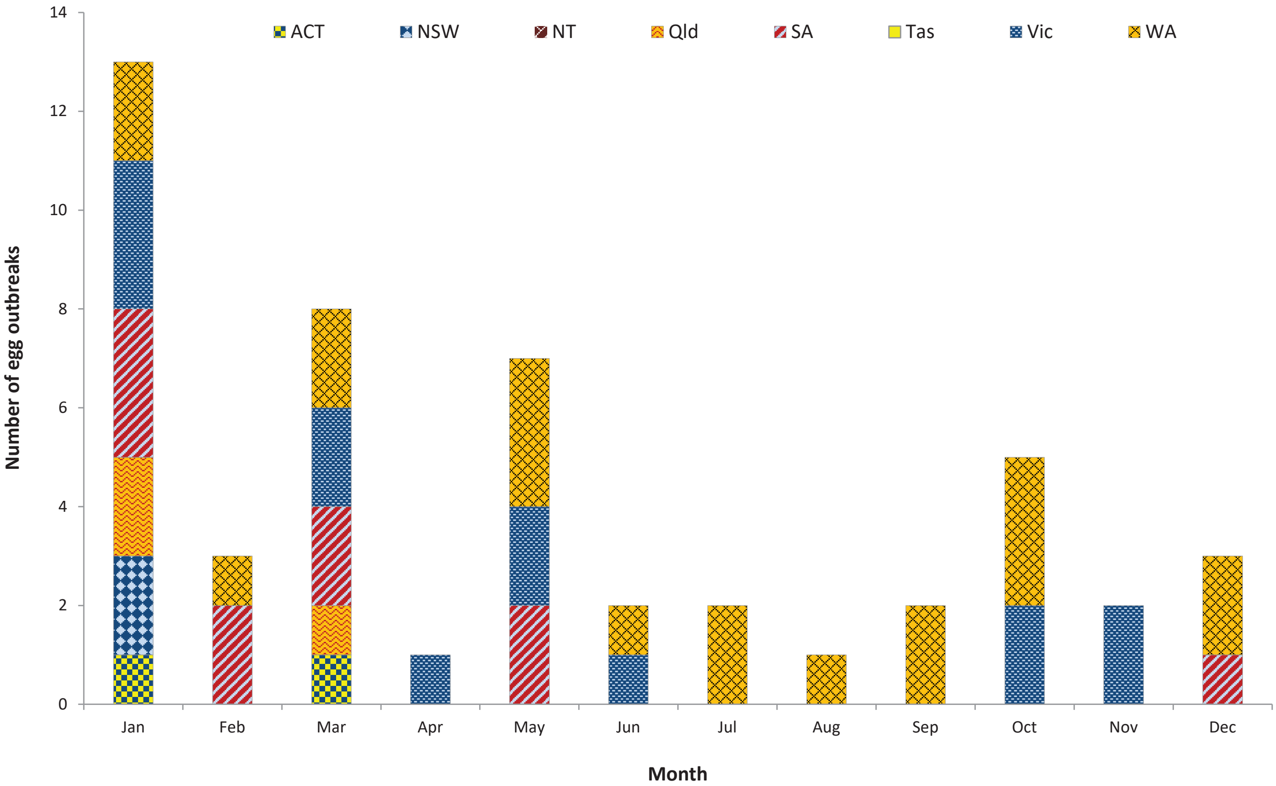
Eggs

Outbreaks of salmonellosis associated with the consumption of raw or minimally-cooked egg products are an important cause of foodborne outbreaks in Australia.[25,26] Eggs were identified as the probable or confirmed source for 49 foodborne outbreaks reported in 2017 (27%). With the exception of Tasmania and Northern Territory, egg-related outbreaks occurred throughout the country (19 in Western Australia, 13 in Victoria, ten in South Australia, three in Queensland and two each in the Australian Capital Territory and New South Wales). Egg-associated outbreaks peaked in January (n = 13) (Figure 24). These outbreaks affected 746 people, of which 163 were admitted to hospital. Egg-associated outbreaks included 48 *S.* Typhimurium outbreaks with 35 different MLVA profiles identified, and a single *S.* Hessarek outbreak. The setting of preparation was most commonly a restaurant (n = 26, 53%), followed by a private residence (n = 9, 18%). The most commonly implicated foods in egg associated outbreaks were sauces made with raw eggs (n = 14, 29%) and desserts containing raw eggs (n = 12, 24%). See Appendix B for further details.

Table 25: Foodborne outbreaks in Australia by aetiology and food commodity, 2017

Aetiology	Dairy	Eggs (including raw/ lightly cooked/ binding agent)	Grains	Meat	Poultry	Produce	Sauces (non-egg)	Seafood	Mixed/ multiple foods	Not attributed
Campylobacter	1	0	0	2	1	0	0	0	0	2
Ciguatoxin	0	0	0	0	0	0	0	9	0	0
Clostridium perfringens	0	0	0	1	0	0	0	0	1	3
Cryptosporidium	1	0	0	0	0	0	0	0	0	0
Hepatitis A	0	0	0	0	0	1	0	0	0	0
Listeria monocytogenes	0	0	0	0	0	0	0	0	0	1
Norovirus	0	0	0	0	0	0	0	0	5	6
Salmonella	0	49	1	4	5	0	1	1	9	32
Shigella	0	0	0	0	0	0	0	0	1	1
Vibrio albensis	0	0	0	0	0	0	0	1	0	0
Unknown	0	0	0	2	5	0	0	2	7	24
Total	**2**	**49**	**1**	**9**	**11**	**1**	**1**	**13**	**23**	**69**

Figure 24: Egg outbreaks by month and jurisdiction in Australia, 2017



Seafood

Seafood (comprising of the three commodities of fish, molluscs and crustaceans) was implicated as the source in 13 foodborne outbreaks reported in 2017. Aetiological agents identified included ciguatoxin (n = 9), *S.* Muenchen (n = 1), and *V. albensis* (n = 1). Two outbreaks had an unknown aetiological agent.

Ciguatera fish poisoning outbreaks occurred throughout the year, and occurred primarily in Queensland (n = 7). Seven outbreaks were due to the consumption of fish caught by recreational fisherman, one outbreak was due to consumption of fish at a restaurant (assumed to be a non-recreational catch), and one outbreak was due to consumption of a fish that had been purchased at a market in Fiji by an individual and transported to Australia (where it was consumed).

Settings

Restaurants were the most commonly-reported food preparation setting accounting for just over half of all foodborne outbreaks (n = 93; 52%) and just over half of the total number of ill people reported during outbreaks in 2017 (n = 1,092; 51%) (Table 26).

Level of evidence for foodborne outbreaks

There was statistical evidence of an association between the consumption of the implicated food and illness for 30 foodborne outbreaks in 2017, ascertained from 15 point-source cohort studies and 15 case-control studies. An additional three 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 13 outbreaks. Compelling descriptive evidence alone supported foodborne transmission for the remaining 133 outbreaks in 2017 (Table 27).

Table 26: Foodborne outbreaks in Australia by setting prepared, 2017

Setting prepared	Outbreaks		Ill people		Hospitalisations	
	N	% of all outbreaks	N	% of all ill people	N	% of all hospitalisations
Restaurant	93	52%	1,092	51%	144	50%
Private residence	19	11%	117	5%	20	7%
Primary production	12	7%	93	3%	19	7%
Aged care facility	11	6%	91	4%	9	3%
Commercial caterer	9	5%	206	10%	16	6%
Take-away	8	4%	82	4%	23	8%
Bakery	6	3%	149	7%	24	8%
Cruise ship	3	2%	34	2%	0	0%
Community	3	2%	29	1%	2	1%
Correctional facility	3	2%	8	0%	3	1%
Hospital	3	2%	9	0%	6	2%
Mining camp	2	1%	71	3%	5	2%
Child care centre	2	1%	44	2%	3	1%
School	1	1%	24	1%	2	1%
Private caterer	1	1%	34	2%	1	0%
Church	1	1%	36	2%	10	3%
Picnic	1	1%	9	0%	2	1%
Fair/festival/mobile service	1	1%	2	0%	1	0%
Total	**179**	**100%**	**2,130**	**100%**	**290**	**100%**

Table 27: Evidence to support foodborne transmission for outbreaks in Australia, 2017

Aetiological agent	Statistical	Statistical and microbiological	Compelling descriptive	Microbiological and compelling descriptive	Total
Campylobacter	1	0	4	1	6
Ciguatoxin	0	0	9	0	9
Clostridium perfringens	0	0	5	0	5
Cryptosporidium	0	0	1	0	1
Hepatitis A	0	0	0	1	1
Listeria monocytogenes	0	0	1	0	1
Norovirus	7	0	4	0	11
Salmonella	13	3	75	11	102
Shigella	0	0	2	0	2
Vibrio albensis	0	0	1	0	1
Unknown	9	0	31	0	40
Total	**30**	**3**	**133**	**13**	**179**

Multi-jurisdictional foodborne outbreak investigations in 2017

OzFoodNet undertook one multi-jurisdictional outbreak investigation (MJOI) in 2017.

Hepatitis A

In May 2017, OzFoodNet initiated a MJOI into cases of hepatitis A linked to consumption of imported frozen mixed berries. A total of 11 cases were linked to the outbreak, including ten confirmed cases (four in Queensland, three in South Australia, two in New South Wales and one in Victoria). One additional probable case, assessed as secondary transmission from a confirmed case occurred in South Australia. Confirmed cases included six females and four males, age range 11 to 75 years (median 37 years), with five of the ten cases hospitalised (50%) for their illness. All confirmed cases spent their entire acquisition period in Australia. Frozen mixed berries were the most commonly reported food exposure, with 70% of confirmed cases (7/10) reporting consumption of frozen mixed berries, with 71% (5/7) of these reporting eating the same brand. Nine samples of the implicated brand of frozen mixed berries were tested for HAV, with HAV subsequently detected in three samples (including two sealed packets and one open packet, all from confirmed outbreak case households). The imported frozen mixed berry product, which contained frozen berries imported from two countries which were re-packaged in Australia, was identified as the source of the outbreak and a consumer recall occurred on 2 June 2017. The 2017 outbreak was found to be genomically linked to a 2015 hepatitis A outbreak in Australia, which was also associated with consumption of imported frozen berries.

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

Animals were the source of three gastrointestinal outbreaks reported in 2017 including two petting zoo outbreaks in South Australia and a single farm outbreak in Western Australia (Table 21). The petting zoo outbreaks each affected six individuals, with aetiological agents identified as cryptosporidium and STEC. Cryptosporidium was the identified agent in the remaining outbreak affecting two visitors to a farm. Animal-to-person outbreaks are rarely identified in Australia, with a total of seven reported in the previous five years including two associated with petting zoos, two with pets at aged care facilities, two with pet chickens at a child-care centre and a single outbreak on a farm.

Waterborne and probable waterborne outbreaks

Waterborne outbreaks (including confirmed and probable outbreaks) are rare in Australia, with a total of eight reported in the previous five years. Two waterborne outbreaks were reported in 2017 (Table 21), including a *S.* Wangata outbreak affecting ten attendees at a yoga retreat in New South Wales following consumption of spring water, and a *S.* Saintpaul outbreak affecting six workers from a remote mining camp in the Northern Territory related to a non-public water supply.

Environmental and probable environmental outbreaks

Twenty-two environmental outbreaks (including confirmed and probable outbreaks) were reported in 2017 affecting 225 people (Table 21). All were cryptosporidium outbreaks following exposure at swimming pools. With the exception of a suspected viral outbreak associated with a Victorian water play park in 2012 and a *S.* Chester outbreak linked to a mud-run event in Victoria in 2016, all environmental outbreaks reported since 2012 have been cryptosporidium outbreaks associated with swimming pools. Note while swimming pools and other swimming facilities that are associated with more the one case of cryptosporidiosis in New South Wales are reviewed for compliance with state requirements, data is not included in this report as they are not reported as outbreaks. As a result of this and other differences in reporting across jurisdictions, 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, 2017

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
MJOI	May	Primary production	Hepatitis A	11	5	0	DM	Case series	Imported frozen mixed berries	Produce	Ingestion of contaminated raw products
ACT	Jan	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523 and MLVA 03-26-13-08-523	119	20	0	A	Case control study	Multiple foods contaminated with raw eggs	Eggs	Cross contamination from raw ingredients, inadequate cleaning of equipment
ACT	Feb	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	7	4	0	DM	Case series	Chicken and multiple foods contaminated by chicken	Poultry	Unknown
ACT	Feb	Restaurant	*S.* Typhimurium, MLVA 03-25-13-12-523	11	4	0	D	Case series	Unknown	Not attributed	Cross contamination from raw ingredients
ACT	Mar	Restaurant	*S.* Typhimurium, MLVA 03-09-07-12-523	2	2	0	D	Case series	Caesar salad dressing containing raw eggs	Eggs	Inadequate cleaning of equipment, cross contamination from raw ingredients
ACT	Apr	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	5	3	0	D	Case series	Sushi	Mixed/multiple	Cross contamination from raw ingredients
ACT	May	Restaurant	Unknown (suspected viral)	6	0	0	D	No formal study	Unknown	Not attributed	Unknown
ACT	May	Restaurant	Unknown (suspected viral)	14	0	0	D	Case series	Unknown	Not attributed	Unknown
ACT	Jun	Restaurant	Unknown	4	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jan	Picnic	*S.* Typhimurium, MLVA 03-17-09-12-523	9	2	0	D	No formal study	French toast made with raw eggs	Eggs	Ingestion of contaminated raw products
NSW	Jan	Restaurant	*S.* Typhimurium, MLVA 03-16-09-07-523	17	Unknown	0	D	Case series	Multiple foods containing eggs or contaminated by eggs	Eggs	Ingestion of contaminated raw products, cross contamination from raw ingredients
NSW	Jan	Cruise ship	*S.* Enteritidis	10	0	0	D	Case series	Unknown	Not attributed	Unknown
NSW	Jan	Private residence	*S.* Enteritidis	5	0	0	D	No formal study	Unknown	Not attributed	Ingestion of contaminated raw products, cross contamination from raw ingredients
NSW	Jan	Take-away	Unknown (suspected toxin)	5	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Feb	Restaurant	Ciguatoxin	4	4	0	D	No formal study	Grouper fish	Seafood	Toxic substance or part of tissue

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Feb	Restaurant	*Vibrio albensis*	3	1	0	D	No formal study	Oysters	Seafood	Unknown
NSW	Feb	Aged care facility	*Campylobacter*	3	1	0	D	Case series	Unknown	Not attributed	Unknown
NSW	Feb	Restaurant	*S.* Typhimurium, MLVA 03-17-9-12-523	3	0	0	D	No formal study	Unknown	Not attributed	Cross contamination from raw ingredients
NSW	Mar	Restaurant	Unknown (suspected toxin)	4	0	0	D	No formal study	Curries	Mixed/multiple	Unknown
NSW	Mar	Community	*Campylobacter*	21	0	0	A	Point source cohort	Unknown	Not attributed	Unknown
NSW	Mar	Restaurant	Unknown (suspected toxin)	3	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Mar	Restaurant	Unknown (suspected viral)	5	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Apr	Private residence	*S.* Typhimurium, MLVA 03-24-13-10-523	6	1	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Apr	Restaurant	Unknown (suspected toxin)	3	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jun	Commercial caterer	Unknown (suspected viral)	48	0	0	A	Point source cohort	Salads	Mixed/multiple	Other source of contamination
NSW	Jun	Private caterer	Norovirus	34	1	0	A	Point source cohort	Unknown	Not attributed	Person to food to person
NSW	Jul	Commercial caterer	Unknown (suspected viral)	24	0	0	A	Point source cohort	Sandwiches and wraps	Mixed/multiple	Unknown
NSW	Jul	Restaurant	Norovirus	12	0	0	A	Point source cohort	Unknown	Not attributed	Unknown
NSW	Jul	Restaurant	Unknown (suspected toxin)	6	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jul	Restaurant	Unknown (suspected toxin)	32	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Jul	Restaurant	Unknown (suspected viral)	16	0	0	D	No formal study	Unknown	Not attributed	Person to food to person

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NSW	Aug	Commercial caterer	Norovirus	32	1	0	A	Point source cohort	Ravioli	Mixed/multiple	Food handler contamination, inadequate washing of food eaten uncooked
NSW	Sep	Restaurant	Unknown	13	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Sep	Commercial caterer	Unknown (suspected viral)	17	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Oct	Restaurant	*S.* Singapore	3	0	0	D	No formal study	Chicken wraps	Poultry	Cross contamination from raw ingredients
NSW	Oct	Restaurant	Unknown	8	0	0	D	no formal study	Unknown	Not attributed	Unknown
NSW	Oct	Restaurant	Unknown	6	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Oct	Restaurant	Unknown (suspected toxin)	5	0	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Nov	Restaurant	Unknown (suspected toxin)	8	0	0	D	No formal study	Chicken skewers	Poultry	Unknown
NSW	Nov	Cruise ship	*S.* Enteritidis	8	Unknown	0	D	Case series	Unknown	Not attributed	Unknown
NSW	Nov	Restaurant	Unknown (suspected toxin)	20	1	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Dec	Restaurant	*Campylobacter*	2	0	0	D	No formal study	Lamb liver	Meat	Unknown
NSW	Dec	Private residence	Unknown (suspected toxin)	4	0	0	D	No formal study	Tuna with salad	Seafood	Unknown
NSW	Dec	Restaurant	Norovirus	8	2	0	D	No formal study	Unknown	Not attributed	Unknown
NSW	Dec	Restaurant	Unknown (suspected toxin)	9	0	0	D	No formal study	Unknown	Not attributed	Unknown
NT	Mar	Fair/festival/ mobile service	*S.* Wandsworth	2	1	0	D	No formal study	Gravy	Sauces (non-egg)	Unknown
NT	Apr	Restaurant	Unknown	2	1	0	D	No formal study	Grilled chicken	Poultry	Ingestion of contaminated raw products
NT	May	Restaurant	Unknown	5	0	0	D	No formal study	Unknown	Not attributed	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
NT	Jun	Primary production	*S.* Muenchen	20	2	0	D	Case series	Green turtle meat	Seafood	Ingestion of contaminated raw products, inadequate washing of food eaten uncooked
NT	Jul	Restaurant	*Shigella spp.*	2	0	0	D	Case series	Unknown	Not attributed	Unknown
NT	Oct	Restaurant	Unknown	2	0	0	D	Case series	Roast lamb	Meat	Unknown
NT	Dec	Restaurant	Unknown	62	1	0	A	Point source cohort	Chicken chasseur	Poultry	Other source of contamination
Qld	Jan	Restaurant	*S.* Typhimurium, MLVA 03-12-10-10-523	48	16	0	AM	Point source cohort	Fried ice cream	Eggs	Cross contamination from raw ingredients, inadequate cleaning of equipment
Qld	Jan	Church	*S.* Weltevreden	36	10	0	AM	Point source cohort	Roast pork	Meat	Unknown
Qld	Jan	Hospital	*Listeria monocytogenes*, MLST 3, MLVA 04-17-16-05-03-11-14-00-16, Binary type 159	3	3	0	D	Case series	Unknown	Not attributed	Inadequate cleaning of equipment
Qld	Jan	Restaurant	*S.* Typhimurium, MLVA 03-12-12-11-523	3	0	0	D	Case series	Unknown	Not attributed	Unknown
Qld	Jan	Restaurant	*S.* Typhimurium, MLVA 03-12-11-11/12-523	13	4	0	D	Case series	Vietnamese rolls with raw egg aioli	Eggs	Ingestion of contaminated raw products
Qld	Feb	Restaurant	*S.* Mbandaka	9	0	0	DM	Case series	Rice noodles	Grains	Cross contamination from raw ingredients, inadequate cleaning of equipment
Qld	Feb	Aged care facility	*S.* Typhimurium, MLVA 03-12-10-11-523	5	1	0	D	No formal study	Unknown	Not attributed	Unknown
Qld	Feb	Restaurant	*S.* Typhimurium, MLVA 03-12-12-10/11-523	15	1	0	D	Case series	Unknown	Not attributed	Cross contamination from raw ingredients
Qld	Mar	Primary production	Ciguatoxin	2	0	0	D	Case series	Coral Trout	Seafood	Toxic substance or part of tissue
Qld	Mar	Restaurant	*S.* Typhimurium, MLVA 03-15-12-11-523	2	2	0	DM	Case series	Fried ice cream	Eggs	Ingestion of contaminated raw products, cross contamination from raw ingredients

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Qld	Mar	Restaurant	*S.* Typhimurium, MLVA 03-12-12-11-523	6	3	0	D	Case series	Unknown	Not attributed	Inadequate cleaning of equipment, cross contamination from raw ingredients
Qld	Jul	Primary production	Ciguatoxin	2	0	0	D	Case series	Fish (unspecified)	Seafood	Toxic substance or part of tissue
Qld	Aug	Primary production	Ciguatoxin	4	0	0	D	Case series	Coral trout	Seafood	Toxic substance or part of tissue
Qld	Aug	Restaurant	*Clostridium perfringens*	4	0	0	D	Case series	Roast pork and gravy rolls	Meat	Other source of contamination
Qld	Aug	Primary production	Ciguatoxin	2	0	0	D	Case series	Spanish mackerel	Seafood	Toxic substance or part of tissue
Qld	Sep	Primary production	Ciguatoxin	7	0	0	D	Case series	Cod fish	Seafood	Toxic substance or part of tissue
Qld	Sep	Primary production	Ciguatoxin	4	0	0	D	Case series	Spanish mackerel	Seafood	Toxic substance or part of tissue
Qld	Oct	Private residence	*S.* Saintpaul	7	0	0	D	Case series	Goat meat or offal	Meat	Cross contamination from raw ingredients
Qld	Nov	Primary production	Ciguatoxin	2	0	0	D	No formal study	Mackerel	Seafood	Toxic substance or part of tissue
Qld	Nov	Restaurant	*S.* Hvittingfoss	18	0	0	D	Case series	Unknown	Not attributed	Cross contamination from raw ingredients, inadequate cleaning of equipment
Qld	Dec	Community	*S.* Typhimurium, MLVA 03-13-12-09-523	3	1	0	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
SA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-15-06-11-550	6	1	0	D	Case series	Multiple breakfast egg dishes	Eggs	Unknown
SA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-14-10-10-523	6	2	0	D	Case series	Multiple foods including aioli containing raw eggs	Eggs	Ingestion of contaminated raw products
SA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-14-09-11-523	4	0	0	D	Case series	Multiple foods including raw egg sauces	Eggs	Cross contamination from raw ingredients

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
SA	Feb	Restaurant	*S.* Typhimurium, MLVA 03-14-09-11-523	9	1	0	D	Case series	Multiple foods contaminated with raw eggs	Eggs	Cross contamination from raw ingredients
SA	Feb	Bakery	*S.* Typhimurium, MLVA 03-14-09-11-523	14	6	0	DM	Case series	Pies with post-cook raw egg wash	Eggs	Cross contamination from raw ingredients
SA	Mar	Restaurant	*Campylobacter jejuni*	12	0	0	D	Case series	Chicken	Poultry	Ingestion of contaminated raw products
SA	Mar	Primary production	*S.* Hessarek	27	11	0	DM	Case series	Eggs	Eggs	Food handler contamination, inadequate washing of food eaten uncooked
SA	Mar	Aged care facility	*S.* Typhimurium, MLVA 03-16-09-12-523	13	3	1	A	Case control study	Multiple foods contaminated with raw eggs	Eggs	Cross contamination from raw ingredients
SA	Mar	Restaurant	*S.* Typhimurium, MLVA 05-15-17-09-490	13	3	0	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products, cross contamination from raw ingredients
SA	May	Private residence	*S.* Typhimurium, MLVA 03-27-16-11-523	5	1	0	D	No formal study	Chocolate mousse containing raw eggs	Eggs	Unknown
SA	May	School	*S.* Typhimurium, MLVA 03-23-12-10-523	24	2	0	A	Point source cohort	Raw cake mixture	Eggs	Cross contamination from raw ingredients, inadequate cleaning of equipment
SA	Jun	Primary production	Cryptosporidium	7	0	0	D	Case series	Raw milk	Dairy	Ingestion of contaminated raw products
SA	Jul	Take-away	*S.* Typhimurium, MLVA 03-14-10-08-523	4	1	0	DM	Case series	Stir fry dishes	Mixed/multiple	Cross contamination from raw ingredients
SA	Oct	Restaurant	*Campylobacter*	13	0	0	DM	No formal study	Chicken pâté	Meat	Ingestion of contaminated raw products
SA	Oct	Take-away	*S.* Newport	12	1	0	D	Case series	Vietnamese meat rolls	Meat	Cross contamination from raw ingredients
SA	Dec	Bakery	*S.* Typhimurium, MLVA 03-14-11-08-523	73	13	1	D	Case series	Sandwiches/wraps/ rolls containing chicken/ contaminated by eggs	Eggs	Cross contamination from raw ingredients
SA	Dec	Take-away	*S.* Typhimurium, MLVA 03-22-16-10-523	19	8	0	D	Case series	Sushi	Mixed/multiple	Cross contamination from raw ingredients
Tas.	Feb	Restaurant	Unknown (suspected toxin)	10	0	0	D	Case series	Rice or curry	Mixed/multiple	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Tas.	Apr	Restaurant	Norovirus	32	0	0	A	Case control and cohort	Hummus and vegetable dish	Mixed/multiple	Unknown
Tas.	May	Restaurant	Unknown (suspected toxin)	10	0	0	A	Point source cohort	Unknown	Not attributed	Unknown
Tas.	Nov	Restaurant	Unknown (suspected toxin)	3	0	0	D	No formal study	Unknown	Not attributed	Unknown
Tas.	Dec	Restaurant	*S.* Typhimurium, MLVA 03-14-17-09-523	2	0	0	D	Case series	Rice paper rolls	Mixed/multiple	Unknown
Vic.	Jan	Commercial caterer	*S.* Typhimurium, MLVA 03-13-10-09-523	22	12	1	A	Case control study	Baked pear dessert	Not attributed	Cross contamination from raw ingredients
Vic.	Jan	Commercial caterer	*S.* Typhimurium, MLVA 03-13-10-09-523	11	2	0	A	Point source cohort	Egg, lettuce and pesto sandwiches	Eggs	Unknown
Vic.	Jan	Private residence	*S.* Typhimurium, MLVA 03-09-09-12-523	5	0	0	D	Case series	Hamburger patties (undercooked)	Meat	Ingestion of contaminated raw products
Vic.	Jan	Correctional facility	*S.* Typhimurium, MLVA 03-17-09-12-523	2	0	0	D	Case series	Ice cream made with raw eggs	Eggs	Ingestion of contaminated raw products
Vic.	Jan	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	5	3	0	A	Case control study	Lemon duck	Poultry	Unknown
Vic.	Jan	Correctional facility	*Campylobacter*	2	0	0	D	Case series	Raw milk	Dairy	Ingestion of contaminated raw products
Vic.	Jan	Private residence	*S.* Typhimurium, MLVA 03-09-09-13-523	5	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Jan	Restaurant	Unknown	16	0	0	D	Case control study	Unknown	Not attributed	Unknown
Vic.	Jan	Bakery	*S.* Typhimurium, MLVA 03-09-09-14-523	19	0	0	D	Case series	Vietnamese rolls with raw egg butter	Eggs	Ingestion of contaminated raw products

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Vic.	Feb	Restaurant	Unknown	10	0	0	A	Point source cohort	Mixed curries	Mixed/multiple	Unknown
Vic.	Feb	Restaurant	Norovirus	31	3	0	A	Point source cohort	Multiple foods served on platters	Mixed/multiple	Person to food to person
Vic.	Feb	Aged care facility	*Clostridium perfringens*	8	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Feb	Private residence	*S.* Typhimurium, MLVA 03-26-12-11-523	8	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Feb	Aged care facility	Unknown	12	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Mar	Aged care facility	*Clostridium perfringens*	9	0	0	D	Case series	Beef ravioli or mushroom soup	Mixed/multiple	Unknown
Vic.	Mar	Restaurant	*S.* Typhimurium, MLVA 03-24-12-11-523	31	17	0	A	Case control study	Hollandaise sauce containing raw eggs	Eggs	Ingestion of contaminated raw products
Vic.	Mar	Restaurant	*S.* Typhimurium, MLVA 03-24-13-11-523	7	2	0	DM	Case series	Special fried rice or beef dish	Mixed/multiple	Unknown
Vic.	Mar	Restaurant	*S.* Typhimurium, MLVA 03-11-11-14-523	4	2	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Mar	Restaurant	*S.* Typhimurium, MLVA 03-24-12-11-523	7	3	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Mar	Take-away	*S.* Typhimurium, MLVA 03-14-08-13-523	4	1	0	D	Case series	Vietnamese rolls with raw egg butter	Eggs	Ingestion of contaminated raw products
Vic.	Apr	Correctional facility	*S.* Typhimurium, MLVA 03-26-13-08-523	4	3	0	D	Case series	Ice cream made with raw eggs	Eggs	Ingestion of contaminated raw products
Vic.	May	Primary production	Ciguatoxin	5	1	0	D	Case series	Coral trout	Seafood	Toxic substance or part of tissue

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Vic.	May	Restaurant	Norovirus	20	0	0	A	Case control study	Multiple foods including canapes, black forest cupcake, and lemon meringue cheesecake	Mixed/multiple	Unknown
Vic.	May	Restaurant	Unknown	19	0	0	A	Case control study	Rare seared tuna	Seafood	Person to food to person
Vic.	May	Restaurant	*S.* Typhimurium, MLVA 03-09-09-14-523	22	7	0	A	Case control study	Raw egg sauces	Eggs	Ingestion of contaminated raw products
Vic.	May	Restaurant	*S.* Typhimurium, MLVA 03-11-07-11-523	10	6	0	D	Case series	Salmon patties bound with raw eggs	Eggs	Ingestion of contaminated raw products
Vic.	Jun	Restaurant	*S.* Typhimurium, MLVA 03-22-14-11-523	6	0	0	D	Case series	Arancini balls bound with raw egg	Eggs	Ingestion of contaminated raw products
Vic.	Jun	Restaurant	Unknown	3	0	0	D	Case series	Chicken	Poultry	Unknown
Vic.	Jun	Restaurant	Unknown	33	2	0	A	Case control study	Multiple foods including Greek salad, tuna sushi roll, and pistachio éclair	Mixed/multiple	Unknown
Vic.	Jun	Restaurant	*S.* Typhimurium, MLVA 03-22-14-11-523	8	2	0	D	Case series	Multiple foods, suspected cross contamination	Mixed/multiple	Unknown
Vic.	Jun	Aged care facility	Unknown	7	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Sep	Aged care facility	*Clostridium perfringens*	8	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Sep	Aged care facility	*Clostridium perfringens*	10	0	0	D	Case series	Unknown	Not attributed	Unknown
Vic.	Sep	Restaurant	Norovirus	18	0	0	D	Case series	Unknown	Not attributed	Food handler contamination
Vic.	Oct	Take-away	*Shigella sonnei*	3	0	0	D	Case series	Burritos	Mixed/multiple	Food handler contamination

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
Vic.	Oct	Bakery	*S.* Typhimurium, MLVA 03-10-07-11-523	35	3	0	A	Point source cohort	Eclairs with cream	Not attributed	Cross contamination from raw ingredients
Vic.	Oct	Private residence	*S.* Typhimurium, MLVA 03-22-13-11-523	4	2	0	D	Case series	Multiple foods contaminated with raw eggs	Eggs	Ingestion of contaminated raw products
Vic.	Oct	Restaurant	*S.* Typhimurium, MLVA 03-22-13-11-523	9	2	0	DM	Case series	Fried ice cream	Eggs	Ingestion of contaminated raw products
Vic.	Oct	Hospital	Unknown	3	0	0	D	Case series	Roast turkey	Meat	Unknown
Vic.	Nov	Private residence	*S.* Typhimurium, MLVA 03-15-10-08-523	8	3	0	A	Point source cohort	Salad with raw egg mayonnaise	Eggs	Ingestion of contaminated raw products
Vic.	Dec	Restaurant	*S.* Typhimurium, MLVA 03-13-11-12-496	9	2	0	D	Case series	Raw egg mayonnaise	Eggs	Ingestion of contaminated raw products
Vic.	Dec	Aged care facility	Unknown	6	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-25-16-12-523	6	1	0	D	Case series	Breakfast egg dishes	Eggs	Ingestion of contaminated raw products
WA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	5	1	0	D	Case series	Chinese food	Mixed/multiple	Unknown
WA	Jan	Restaurant	*S.* Typhimurium, MLVA 03-26-16-11-523	3	0	0	DM	Case series	Hollandaise sauce containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	Jan	Commercial caterer	*S.* Typhimurium, MLVA 03-17-09-12-523	22	1	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jan	Cruise ship	*S.* Typhimurium, MLVA 03-17-09-12-523	16	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Jan	Restaurant	*S.* Typhimurium, MLVA 05-14-14-11-490	6	1	0	D	Case series	Unknown	Not attributed	Unknown
WA	Feb	Private residence	*S.* Typhimurium, MLVA 03-17-09-12-523	5	3	0	D	Case series	Arancini balls bound with raw egg	Eggs	Ingestion of contaminated raw products, cross contamination from raw ingredients
WA	Feb	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	42	1	0	AM	Point source cohort	Fried rice and honey chicken	Mixed/multiple	Ingestion of contaminated raw products, cross contamination from raw ingredients

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Feb	Take-away	*S.* Typhimurium, MLVA 03-16/17-09-11/12-523	24	10	0	D	Case series	Nasi lemak	Mixed/multiple	Cross contamination from raw ingredients
WA	Mar	Mining camp	*S.* Typhimurium, MLVA 03-20-09-12-523 and MLVA 03-17-09-12-523	62	5	0	A	Case control study	Boiled eggs	Eggs	Other source of contamination
WA	Mar	Private residence	*S.* Paratyphoid B biovar Java	15	2	0	A	Case control study	Chicken curry	Poultry	Unknown
WA	Mar	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	7	2	0	D	Case series	Raw egg mayonnaise/aioli	Eggs	Ingestion of contaminated raw products
WA	Mar	Mining camp	*S.* Typhimurium, MLVA 03-17-09-12-523	9	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Apr	Restaurant	*S.* Typhimurium, MLVA 03-13-11-10-523	4	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	May	Private residence	*S.* Typhimurium, MLVA 03-12-11-10-523	7	0	0	DM	Case series	Chocolate mousse cake containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	May	Child care centre	*S.* Typhimurium, MLVA 03-25-16-11-523	29	2	0	D	Case series	Egg casserole	Eggs	Ingestion of contaminated raw products
WA	May	Private residence	*S.* Typhimurium, MLVA 03-17-09-12-523	5	4	0	D	Case series	Fresh pasta containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	Jun	Bakery	*S.* Typhimurium, MLVA 03-17-09-13-523	5	1	0	D	Case series	Cakes	Not attributed	Ingestion of contaminated raw products
WA	Jun	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	13	3	0	D	Case series	Vietnamese rolls with raw egg butter	Eggs	Ingestion of contaminated raw products
WA	Jul	Take-away	Norovirus	11	2	0	A	Case control study	Donuts	Not attributed	Person to food to person
WA	Jul	Child care centre	*S.* Typhimurium, MLVA 03-14-09-11-523	15	1	0	D	Case series	Pikelets	Eggs	Ingestion of contaminated raw products
WA	Jul	Private residence	*S.* Typhimurium, MLVA 03-17-10-12-523	3	3	0	DM	Case series	Raw muffin batter containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	Jul	Community	*S.* Muenchen	5	1	0	D	Case series	Unknown	Not attributed	Unknown

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Aug	Private residence	*S.* Typhimurium, MLVA 03-17-09-12-523	5	0	0	A	Case control study	Chicken	Poultry	Cross contamination from raw ingredients
WA	Aug	Bakery	*S.* Typhimurium, MLVA 03-12-11-10-523	3	1	0	D	Case series	Custard filled cake	Not attributed	Unknown
WA	Aug	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	3	0	0	D	Case series	Hamburger patties bound with raw eggs	Eggs	Ingestion of contaminated raw products
WA	Aug	Aged care facility	*S.* Typhimurium, MLVA 03-17-09-12-523	10	4	1	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Aug	Restaurant	*S.* Typhimurium, MLVA 03-17-09-12-523	4	1	0	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Aug	Restaurant	*S.* Typhimurium, MLVA 03-26-16-12-523	2	0	0	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Sep	Private residence	*S.* Typhimurium, MLVA 03-10-15/16-11-496	4	1	0	D	Case series	Chocolate mousse containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	Sep	Restaurant	*S.* Typhimurium, MLVA 03-12-11-10-523	4	1	0	D	Case series	Chocolate soufflé containing raw eggs	Eggs	Ingestion of contaminated raw products
WA	Sep	Hospital	*S.* Typhimurium, MLVA 03-25-17-11-523	3	3	1	D	Case series	Unknown	Not attributed	Ingestion of contaminated raw products
WA	Oct	Restaurant	*S.* Typhimurium, MLVA 03-26-16-12-523	10	1	0	D	Case series	Breakfast egg dishes	Eggs	Ingestion of contaminated raw products
WA	Oct	Commercial caterer	Unknown	17	0	0	A	Case control study	Butter chicken	Poultry	Unknown
WA	Oct	Private residence	*S.* Typhimurium, MLVA 03-12-10-11-523	9	0	0	D	Case series	Meat cannelloni containing eggs	Eggs	Ingestion of contaminated raw products
WA	Oct	Commercial caterer	Unknown	13	0	0	A	Case control study	Multiple foods	Mixed/multiple	Unknown
WA	Oct	Restaurant	*S.* Typhimurium, MLVA 03-12-11-10-523	8	1	0	D	Case series	Multiple foods containing eggs	Eggs	Ingestion of contaminated raw products
WA	Nov	Restaurant	Norovirus	6	0	0	D	Case series	Unknown	Not attributed	Food handler contamination

Jurisdiction[a]	Month[b]	Setting prepared	Agent responsible[c]	No. ill	No. hospitalised	No. fatalities	Evidence[d]	Epidemiological study	Responsible vehicle	Commodity	Contamination factor
WA	Nov	Private residence	*S.* Typhimurium, MLVA 03-17-09-12-523	7	0	0	D	Case series	Unknown	Not attributed	Unknown
WA	Dec	Restaurant	*S.* Typhimurium, MLVA 03-17-09-11/12-523	8	0	0	D	Case series	Arincini made with raw egg mayonnaise or tiramisu	Eggs	Ingestion of contaminated raw products
WA	Dec	Restaurant	Norovirus	9	0	0	D	Case series	Charcuterie board	Mixed/multiple	Unknown
WA	Dec	Restaurant	*S.* Typhimurium, MLVA 03-17-07-12-523	15	4	0	D	Case series	Vietnamese rolls with raw egg butter	Eggs	Ingestion of contaminated raw products

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 month of notification of the first case or the month the investigation into the outbreak commenced.

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

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.