Australian Government
Department of Health

2022 · Volume 46

Communicable Diseases Intelligence

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https://doi.org/10.33321/cdi.2022.46.2
Electronic publication date: 27/1/2022
http://health.gov.au/cdi

Communicable Diseases Intelligence
ISSN: 2209-6051 Online

This journal is indexed by Index Medicus and Medline.

Communicable Diseases Network Australia
Communicable Diseases Intelligence contributes to the work of the Communicable Diseases Network Australia.
http://www.health.gov.au/cdna

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Original article

Salmonellosis in Australia in 2020: possible impacts of COVID-19 related public health measures

Barbara P F Davis, Janaki Amin, Neil Franklin, Paul J Beggs

Abstract

Background

More than seventy per cent of salmonellosis in Australia is thought to be due to contaminated food. Rates of salmonellosis vary across the Australian states and territories, with the highest rates in the Northern Territory. In 2020, to control coronavirus disease 2019 (COVID-19), Australia implemented public health measures including border closures, physical distancing and hygiene advice. This study analyses salmonellosis notification rates in 2020 and considers possible impacts of COVID-19 measures.

Methods

Monthly and annual salmonellosis notifications per 100,000 population, for each of Australia's eight states and territories for the years 2015 to 2020, were extracted from Australia's publicly accessible National Notifiable Diseases Surveillance System. For each jurisdiction, the salmonellosis rate each month in 2020 was compared with the previous 5-year median rate for that calendar month. The possible impacts of COVID-19 public health measures on salmonellosis notifications in the respective states and territories were examined.

Results

The annual Australian salmonellosis notification rate was 27% lower in 2020 than the previous 5-year median. The reduction in salmonellosis rate varied throughout Australia. States and territories with more stringent, more frequent or longer COVID-19 public health measures had generally greater salmonellosis rate reductions. However, Tasmania had a 50% deeper reduction in salmonellosis rate than did the Northern Territory, despite similar restriction levels.

Conclusions

Salmonellosis notifications decreased in Australia during the global COVID-19 pandemic. The reduction in notifications corresponded with the implementation of public health measures. Persistence of high rates in the Northern Territory could indicate the overarching importance of demographic and environmental factors.

Keywords: salmonellosis, rates, notifications, COVID-19, Australia, public health measures

Introduction

Salmonellosis in humans is a predominantly foodborne disease with seasonal variation in rates of infection.[1] Non-typhoidal *Salmonella* species consist of over 2500 serovars and are widely distributed in nature in soil, water, and animal hosts.[2] More than 70% of salmonellosis in Australia is thought to be from contaminated food.[3] Public health efforts to reduce foodborne salmonellosis focus on minimising contamination "during all stages of the food cycle from the farm to consumer".[4] Across Australia there are marked differences in salmonellosis notification rates between jurisdictions, with annual median rates in the Northern Territory (215.3 per 100,000 population per year in 2015–2019) three times the national annual median of 66.6 per 100,000 population per year in 2015–2019 (Appendix A, Figure A.1a).

In 2020, Australia experienced a series of public health challenges, including widespread bushfires and extensive smoke coverage across much of eastern Australia, and the coronavirus disease 2019 (COVID-19) pandemic. A preliminary analysis by Bright et al. found that notifications to June 2020 for most notifiable infectious diseases, including salmonellosis, had declined in Australia, most likely due to public health measures implemented to control COVID-19 including border closures, physical distancing and hygiene advice.[5] Decreases in foodborne diseases in 2020 have also been reported in other countries including the United Kingdom and the United States of America.[6,7]

In this study we have examined salmonellosis rates in Australia and each of its eight states and territories in 2020 and have compared these rates to historical data. We have also explored the possible impacts of COVID-19 public health measures, including the impact of public health measures in high- and low-salmonellosis rate states/territories.

Methods

Data

Salmonellosis notifications

Salmonellosis is a notifiable disease in Australia.[8] Monthly salmonellosis notification numbers and rates (per 100,000 population) for each state and territory, and for Australia as a whole, were extracted on 22 February 2021 from the National Notifiable Diseases Surveillance System (NNDSS) website database for the years 2015 to 2020.[9] Annual salmonellosis notification rates for Australia were extracted on 8 March 2021 from the NNDSS for the years 2015 to 2020.[9]

Australian and state/territory public health measures

Australia-wide and jurisdictional COVID-19 public health measures were obtained from the Prime Minister's media statements; from a Parliament Australia website report, *COVID-19: a chronology of state and territory announcements (up until June 2020)*; and from state and territory government media announcements to the end of December 2020.[10–21] In interpreting the impact of COVID-19 public health measures on salmonellosis notifications, public health measure "commencement" indicates the start of major public health measures such as closure of non-essential businesses. Public health measure "ending" or "easing" indicates the timing for re-opening of businesses and for permission granted to have greater numbers of people at gatherings. Border public health measures are not described in this study.

Analysis

Descriptive data analysis was conducted on the numbers and rates of salmonellosis notifications nationally and by state/territory. Each jurisdiction's median, minimum, and maximum number of salmonellosis notifications per 100,000 was calculated for each calendar month for the years 2015 to 2019. The 2015–2019 median for

each month was used as a better measure of the typical monthly value, because the mean would be more subject to skewing due to occasional salmonellosis outbreaks. For each state/territory, the percentage change in monthly salmonellosis rates from the five-year median to 2020 was calculated by subtracting the five-year median from the 2020 rate and then dividing by the five-year median and converting to a percentage. The annual percentage change for Australia in 2020 was calculated using the same method. The timing of commencement and easing of public health measures in 2020 was included in graphs of the salmonellosis five-year median and 2020 monthly rates for all states and territories.

Results

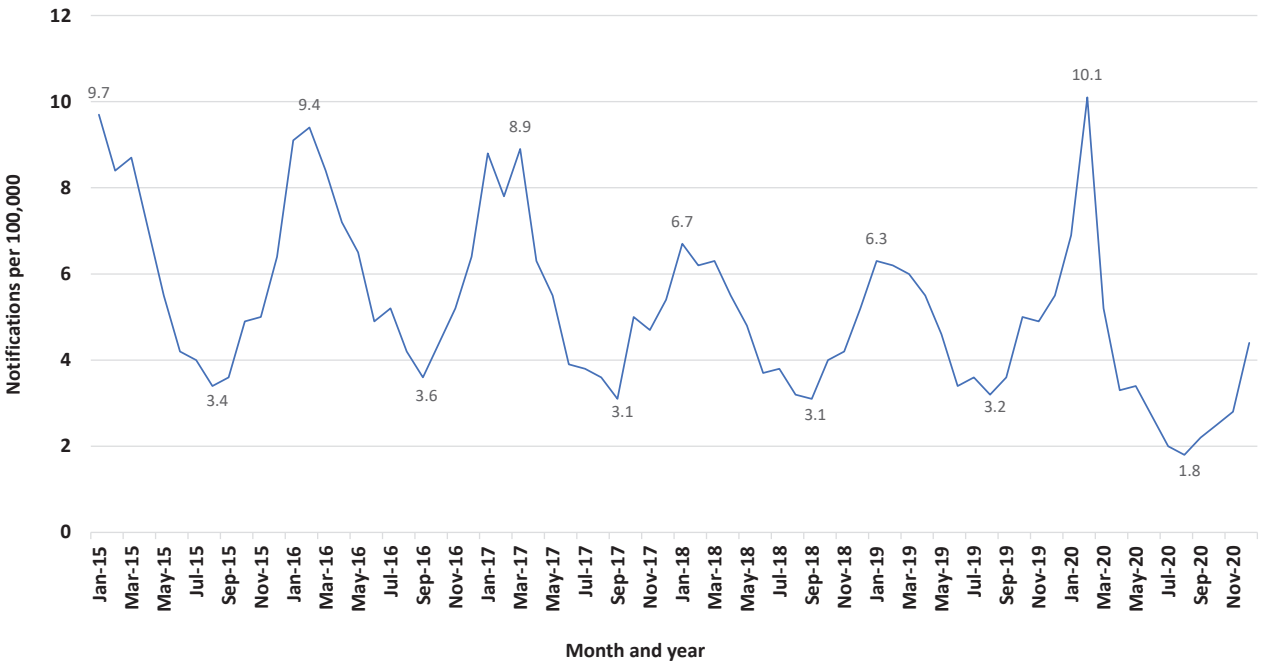
The five-year median number of annual salmonellosis notifications for 2015 to 2019 in Australia was 16,375 (range: 14,146–18,009 notifications per year). In 2020, there were 12,033 salmonellosis notifications in Australia, a 27% reduction on the five-year median and 15% lower than the 2015–2019 five-year minimum.

Figure 1 shows that for each year from 2015 to 2019, Australia's highest monthly salmonellosis notification rate decreased from 9.7 per 100,000 in 2015 to 6.3 per 100,000 in 2019. In 2020, the peak monthly rate was 10.1 per 100,000 in February, the highest for any time in the period 2015 to 2020. For the remaining months in 2020, the rate was consistently below the 5-year medians and minima (Figure 2) and the minimum monthly rate of 1.8 per 100,000 was the lowest for the period 2015–2020.

The Northern Territory had the highest overall monthly salmonellosis rates for 2015–2019, peaking in April 2016 at 42.7 cases per 100,000 (Figure 3). The lowest monthly rate for all the years 2015 to 2020, of 0.7 notifications per 100,000, was recorded for the Australian Capital Territory in July and October 2020. This lowest rate is just 1.6% of the highest Northern Territory rate. The range bars showed wide variation in rates between jurisdictions. The largest range was almost 30 cases per 100,000 per month for February from 2015 to 2019 in the Australian Capital Territory.

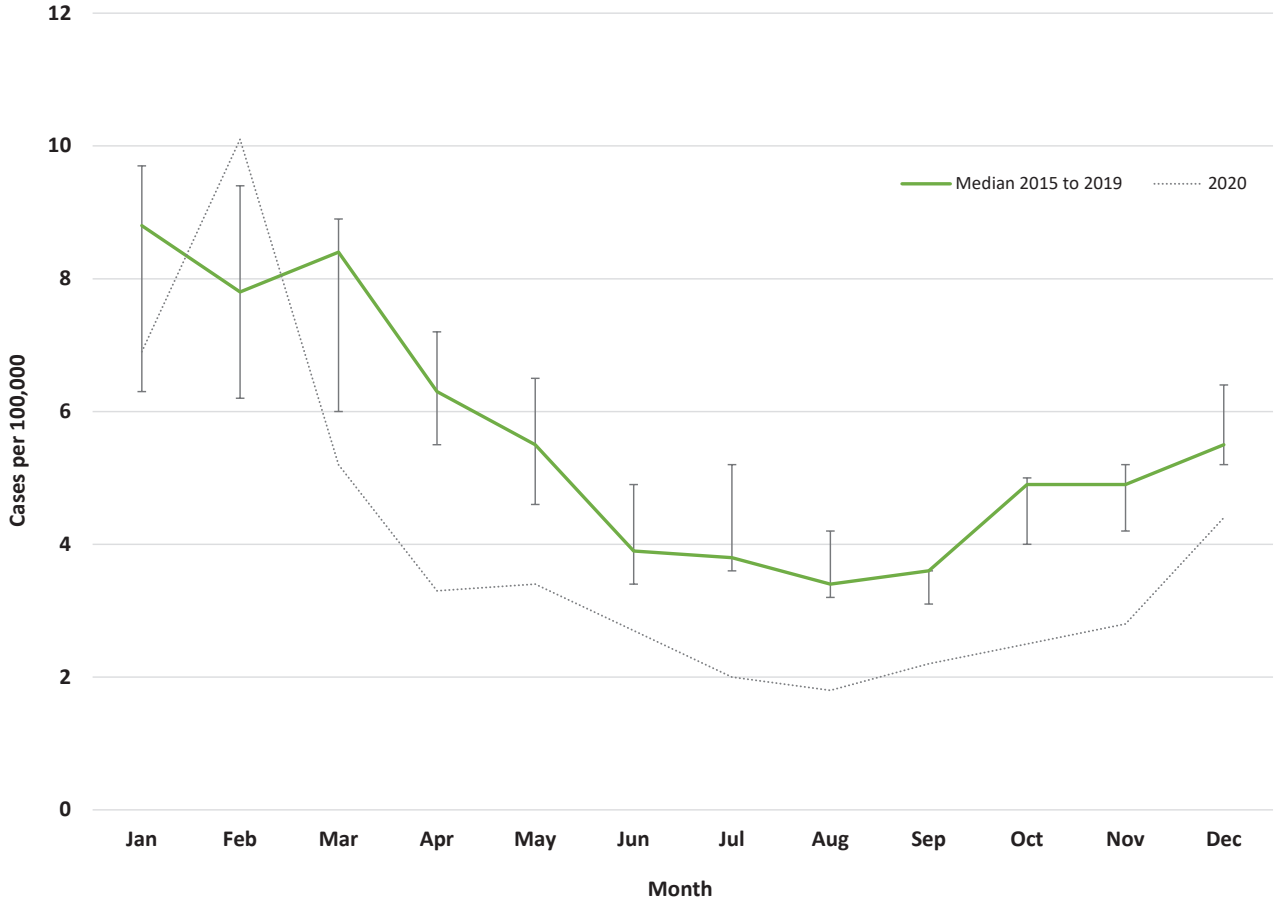
Figure 3 shows that in February 2020 there was an increase in salmonellosis rates compared with the five-year median in six of the eight states and territories of Australia (Northern Territory,

Figure 1: Australian monthly salmonellosis notifications per 100,000,[a] 2015 to 2020



a The rates shown on the graph indicate the maximum and minimum for each year.

Figure 2: Australian monthly salmonellosis notifications per 100,000 for 2020 and monthly medians for 2015 to 2019 with maxima and minima as range bars

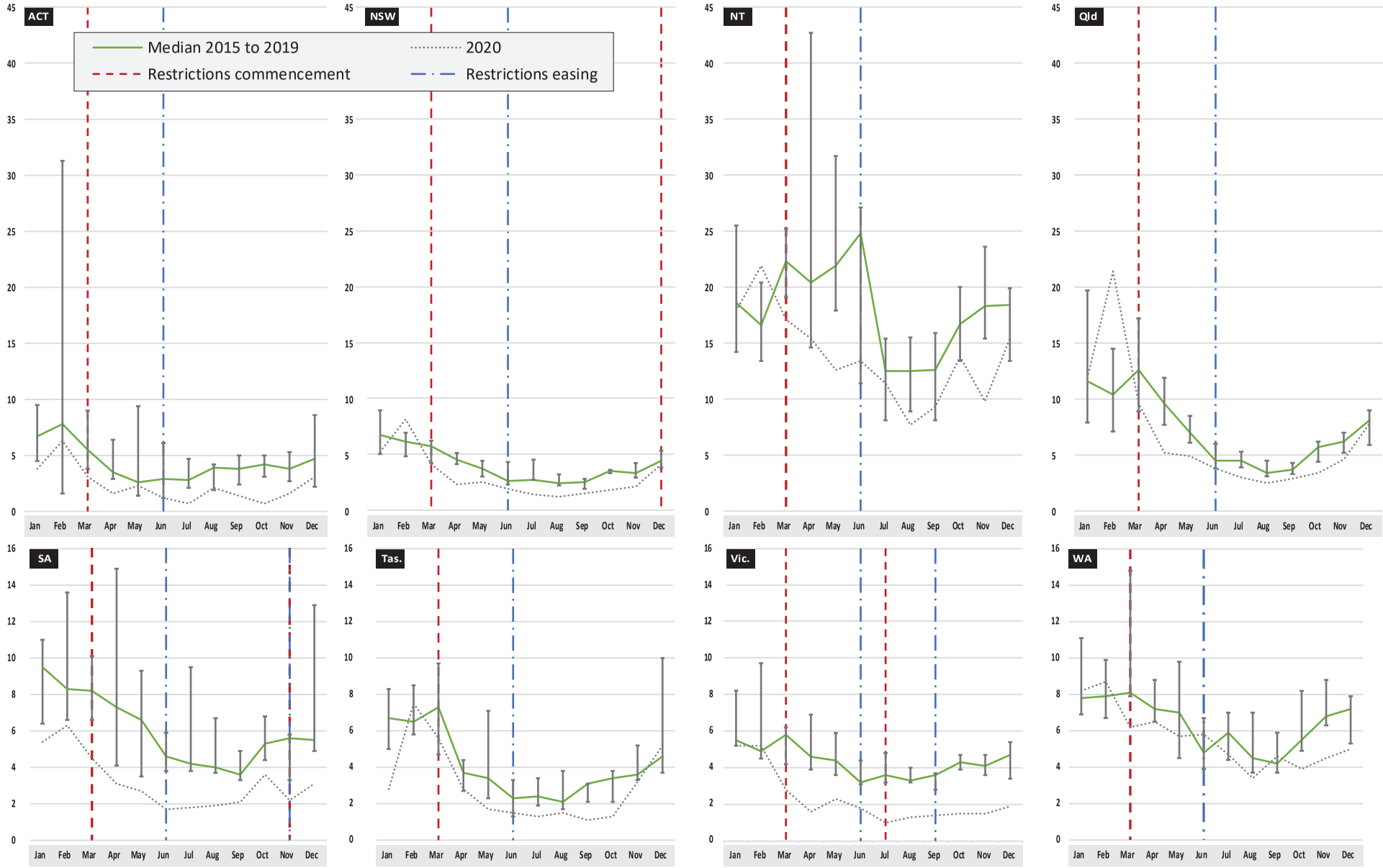


Queensland, Western Australia, New South Wales, Victoria and Tasmania). From March to December 2020, the monthly rates for all jurisdictions were consistently below the five-year median except in June and September for Western Australia and in December for Tasmania (Figure 3; Appendix A, Tables A.1 to A.3). The rates in South Australia, Victoria and New South Wales in 2020 showed prolonged low plateaus. Victoria had the greatest drop and longest plateau coinciding with its two COVID-19 lockdown periods (Appendix A, Box A.1), with rates from March to December 2020 being on average 59.0% lower than the median for these months from the 2015–2019 period. The Australian Capital Territory and South Australia also showed large average decreases in rates in March to December 2020 compared to these months in the 2015-2019 period (52.8% and 51.3% respectively).

Appendix A, Tables A.1 to A.3 show both absolute and percent changes in 2020 from the 2015 to 2019 median salmonellosis rates. The smallest average monthly decreases occurred in Western Australia (12.0%), Queensland (13.2%), and the Northern Territory (21.8%). The Australian Capital Territory had the greatest percent monthly reductions of 83.3% and 75.0%. Victoria had the third greatest percent monthly reduction of 72.2%. Several jurisdictions had minimum monthly rates of around 1 per 100,000 population per month.

Figure 3 shows salmonellosis notification rates in relation to commencement and easing of restrictions. For all jurisdictions, rates decreased below the five-year median at the time of public health measure commencement in March. However, at the time of public health measure easing in June (Table A.4), the notification rates did not decrease as steeply as the seasonal five-year decrease. In the case of Victoria, when public health measures recommenced in July, the rate decreased, in contrast to the five-year median which increased.

Figure 3: Australian state and territory monthly salmonellosis notifications per 100,000 for 2020 and monthly medians for 2015 to 2019 with maxima and minima as range bars, and showing also COVID-19 public health measures (restrictions)



Discussion

This study showed that salmonellosis notifications decreased in Australia in 2020 during the global COVID-19 pandemic, coinciding with the implementation, across Australia, of public health measures on human movement and interaction. Monthly salmonellosis notification rates for the states and territories were consistently below their preceding five-year medians. Monthly salmonellosis rates fell in 2020 by varying amounts throughout Australia and appeared to be influenced by the level of public health measures.

A reduction in total numbers of salmonellosis cases was observed from 2015 to 2019. A decrease in *Salmonella* Typhimurium in New South Wales since 2014 has been attributed in part to the New South Wales Food Authority Foodborne Illness Reduction Strategy.[22] In addition, there has been a national focus on reducing salmonellosis cases through Australia's Foodborne Illness Reduction Strategy.[23] The peak in notifications of salmonellosis in Australia in February 2020 was due to a single large multi-jurisdictional outbreak.[5]

Our study identified that, in 2020, the largest percentage decreases in salmonellosis monthly rates were in Victoria, which had the longest most severe public health measures, and the Australian Capital Territory. A reduced number of restaurant meals and social gatherings where food was produced for large numbers of people likely contributed to a reduction in salmonellosis risk.[5] Indeed, restaurants were the meal preparation location associated with by far the largest proportion (54.1%) of the 869 foodborne outbreaks in New South Wales between 2000 and 2017,[4] as is the case nationally.[24] As Bright et al. commented in their preliminary analysis of the first half of 2020: "While declines in notifications of salmonellosis reflected seasonal trends, physical distancing measures that saw the closure of dine-in services at food businesses also likely contributed to a reduction in case numbers."[5] Similarly, travel public health measures may have reduced the importation of *Salmonella*.[25]

Other factors contributing to the fall in salmonellosis notifications throughout Australia in 2020 may be the Australian population's increased attention to hand and surface hygiene.[26] In addition to reducing cross-contamination of food-borne sources, hand hygiene could also reduce transmission of other environmental sources of *Salmonella*.[27] It is possible that food production safety on farms and processing and transport improved during the year of 2020 as part of general hygiene measures such as those introduced following COVID-19 outbreaks in abattoirs. But it is unlikely that changes in the overall methods of food production would have occurred.

Smaller decreases for monthly percentage changes in salmonellosis were observed in Western Australia, Queensland, and the Northern Territory than in Victoria, New South Wales, South Australia, the Australian Capital Territory and Tasmania. The geographic variation in annual percent change is shown in Appendix Figure A.1b. The smaller decreases for Western Australia, Queensland and the Northern Territory could reflect milder public health measures for Western Australia, Queensland and the Northern Territory. Victoria by comparison had a longer lockdown and South Australia and New South Wales also had additional public health measures.

However, Tasmania—which had similar public health measures to Western Australia, and strict border closure—experienced almost three times the rate reduction seen in Western Australia and almost 50% more than the reduction recorded in the Northern Territory. This difference between states could indicate the importance of environmental and demographic differences. For example, the Northern Territory's tropical climate and higher proportion of young people and Indigenous (Aboriginal and Torres Strait Islander) people are all factors that have been associated with higher salmonellosis rates and

which may have varied the impact of COVID-19 public health measures on salmonellosis rates.[28,29] It could also suggest the importance of a non-foodborne origin of *Salmonella* in Western Australia, Queensland and the Northern Territory, for which the social distancing changes could have had less impact.[30,31] However, Tasmania also has specific environmental *Salmonella* serotypes (e.g., *Salmonella* Mississippi), which account for a large portion of its salmonellosis notifications.[27]

Notifications are likely to under-represent salmonellosis, as not all people with infection are symptomatic; even when symptomatic, not all seek medical treatment or get tested. The latter consideration may have been exacerbated during 2020, due to fears about presenting to clinics being a COVID-19 infection risk. However, a large survey of health service use from January to June 2020 by the Australian Bureau of Statistics found no significant decrease in general practitioner service usage.[32] Medicare Benefits Scheme data show service type changed, with a large drop in face to face attendance between March and June 2020 and a large increase in teleconference health care.[33] In addition, Bright et al. considered the possibility that COVID-19 pathology requirements may have shifted laboratory testing priorities.[5] A 37.4% decline occurred in testing numbers for the Medical Benefits Schedule subsidised test of culture for faeces for faecal pathogens between January and June 2020.[5] While changes in laboratory testing priorities likely contributed to the decline in notified salmonellosis cases, they are unlikely to have fully accounted for the observed decrease. Additionally, a reason why this might not be an underestimation is that salmonellosis tends to peak in younger age groups,[34] and caregivers would be expected to continue to access health services for children.

Limitations

A limitation is that this study used publicly available monthly salmonellosis notification data. There is scope for more detailed investigations with finer resolution temporal (e.g., daily) and spatial (e.g., Health District) data to link the onset of the salmonellosis infections more accurately with the timing of public health measures.

Conclusions

Two phenomena in Australian salmonellosis notifications were observed in 2020. The first was the highest monthly rate since 1991 in February which was associated with a food-related multijurisdictional outbreak. The second was the occurrence of large reductions in jurisdictional rates of salmonellosis across March to December. The second phenomenon, of markedly reduced notifications during COVID-19 public health measures, supports the importance of behavioural factors in the prevention of *Salmonella* infection. Wide-scale application of significant public health measures during COVID-19 appears to have had an impact in reducing infectious diseases including salmonellosis. It is recommended that public health advice continues to promote hand hygiene as this simple intervention has demonstrated to reduce *Salmonella* transmission. Persistence of high salmonellosis rates in northern states compared to southern states, however, suggests the importance of environmental factors and demographic factors in these areas.

Disclosure statement

The authors report no conflict of interest.

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Appendix A

Box A.1. Federal and state/territory government COVID-19 public health measures and advice

On 20 March 2020, the Federal government closed international borders to non- Australians.[20] On 22 March 2020, National Cabinet advised closure of non-essential businesses and reduced size of gatherings at home and for events such as weddings.[19] On 29 March 2020, the National Cabinet's guidance was to stay at home unless for shopping, medical or exercise or work and limited indoor gatherings to two people.[21]

State/territory governments supported National Cabinet advice and implemented public health measures of their own such as lockdowns of specific areas, mask wearing on public transport and in enclosed spaces and interstate border public health measures. State/territory governments relaxed these public health measures when COVID-19 case numbers fell. The timing for these interventions varied across Australia. In all states/territories except Victoria, public health measures were reduced incrementally from June 2020. In Melbourne, Victoria, a second lockdown was put in place from 8 July 2020 until September 2020.[35] By September, Melbourne had experienced four cumulative months of tight public health measures in total. General public health advice issued by state/territory government health departments included 1. handwashing, 2. mask wearing, and 3. physical distancing.

Table A.1: Monthly rate (cases per 100,000) in 2020 compared to the 2015 to 2019 median, for the Australian Capital Territory, New South Wales, and the Northern Territory

	Australian Capital Territory				New South Wales				Northern Territory			
Month	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**
Jan	6.7	3.8	-2.9	-43.3	6.7	5.2	-1.5	-22.4	18.6	17.9	-0.7	-3.8
Feb	7.8	6.3	-1.5	-19.2	6.1	8.1	2.0	32.8	16.6	21.9	5.3	31.9
Mar	5.5	3.1	-2.4	-43.6	5.7	4.1	-1.6	-28.1	22.3	17.1	-5.2	-23.3
Apr	3.5	1.6	-1.9	-54.3	4.5	2.3	-2.2	-48.9	20.4	15.4	-5.0	-24.5
May	2.6	2.3	-0.3	-11.5	3.7	2.5	-1.2	-32.4	21.9	12.6	-9.3	-42.5
Jun	2.9	1.2	-1.7	-58.6	2.6	1.9	-0.7	-26.9	24.8	13.4	-11.4	-46.0
Jul	2.8	0.7	-2.1	-75.0	2.7	1.4	-1.3	-48.2	12.5	11.4	-1.1	-8.8
Aug	3.9	2.1	-1.8	-46.2	2.4	1.2	-1.2	-50.0	12.5	7.7	-4.8	-38.4
Sep	3.8	1.4	-2.4	-63.2	2.5	1.5	-1.0	-40.0	12.6	9.3	-3.3	-26.2
Oct	4.2	0.7	-3.5	-83.3	3.5	1.8	-1.7	-48.6	16.7	13.8	-2.9	-17.4
Nov	3.8	1.6	-2.2	-57.9	3.3	2.1	-1.2	-36.4	18.3	9.8	-8.5	-46.5
Dec	4.7	3.1	-1.6	-34.0	4.4	4.1	-0.3	-6.8	18.4	15.4	-3.0	-16.3
Average (Jan–Dec)	4.4	2.3	-2.0	-49.2	4.0	3.0	-1.0	-29.7	18.0	13.8	-4.2	-21.8
Average (Mar–Dec)	3.8	1.8	-2.0	-52.8	3.5	2.3	-1.2	-36.6	18.0	12.6	-5.5	-29.0

Commun Dis Intell (2018) 2022;46 (https://doi.org/10.33321/cdi.2022.46.2) Epub 27/1/2022

Table A.2: Monthly rate (cases per 100,000) in 2020 compared to the 2015 to 2019 median, for Queensland, South Australia, and Tasmania

	Queensland				South Australia				Tasmania			
Month	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**
Jan	11.6	11.9	0.3	2.6	9.5	5.4	-4.1	-43.2	6.7	2.8	-3.9	-58.2
Feb	10.4	21.4	11.0	105.8	8.3	6.3	-2.0	-24.1	6.5	7.5	1.0	15.4
Mar	12.6	9.6	-3.0	-23.8	8.2	4.5	-3.7	-45.1	7.3	5.6	-1.7	-23.3
Apr	9.6	5.2	-4.4	-45.8	7.3	3.1	-4.2	-57.5	3.7	2.8	-0.9	-24.3
May	7.0	4.9	-2.1	-30.0	6.6	2.7	-3.9	-59.1	3.4	1.7	-1.7	-50.0
Jun	4.5	3.8	-0.7	-15.6	4.6	1.7	-2.9	-63.0	2.3	1.5	-0.8	-34.8
Jul	4.5	3.0	-1.5	-33.3	4.2	1.8	-2.4	-57.1	2.4	1.3	-1.1	-45.8
Aug	3.4	2.5	-0.9	-26.5	4.0	1.9	-2.1	-52.5	2.1	1.5	-0.6	-28.6
Sep	3.7	2.9	-0.8	-21.6	3.6	2.1	-1.5	-41.7	3.1	1.1	-2.0	-64.5
Oct	5.7	3.4	-2.3	-40.4	5.3	3.6	-1.7	-32.1	3.4	1.3	-2.1	-61.8
Nov	6.2	4.6	-1.6	-25.8	5.6	2.2	-3.4	-60.7	3.6	3.2	-0.4	-11.1
Dec	8.1	7.8	-0.3	-3.7	5.5	3.1	-2.4	-43.6	4.6	5.2	0.6	13.0
Average (Jan–Dec)	7.3	6.8	-0.5	-13.2	6.1	3.2	-2.9	-48.3	4.1	3.0	-1.1	-31.2
Average (Mar–Dec)	6.5	4.8	-1.8	-26.6	5.5	2.7	-2.8	-51.3	3.6	2.5	-1.1	-33.1

Table A.3: Monthly rate (cases per 100,000) in 2020 compared to the 2015 to 2019 median, for Victoria, Western Australia, and Australia

	Victoria				Western Australia				Australia			
Month	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**	**2015–2019**	**2020**	**Absolute change**	**% change**
Jan	5.5	5.2	-0.3	-5.5	7.8	8.2	0.4	5.1	**8.8**	**6.9**	**-1.9**	**-21.6**
Feb	4.9	5.2	0.3	6.1	7.9	8.7	0.8	10.1	**7.8**	**10.1**	**2.3**	**29.5**
Mar	5.8	2.8	-3.0	-51.7	8.1	6.2	-1.9	-23.5	**8.4**	**5.2**	**-3.2**	**-38.1**
Apr	4.6	1.6	-3.0	-65.2	7.2	6.5	-0.7	-9.7	**6.3**	**3.3**	**-3.0**	**-47.6**
May	4.4	2.3	-2.1	-47.7	7.0	5.7	-1.3	-18.6	**5.5**	**3.4**	**-2.1**	**-38.2**
Jun	3.2	1.8	-1.4	-43.8	4.8	5.8	1.0	20.8	**3.9**	**2.7**	**-1.2**	**-30.8**
Jul	3.6	1.0	-2.6	-72.2	5.9	4.7	-1.2	-20.3	**3.8**	**2.0**	**-1.8**	**-47.4**
Aug	3.3	1.3	-2.0	-60.6	4.5	3.4	-1.1	-24.4	**3.4**	**1.8**	**-1.6**	**-47.1**
Sep	3.6	1.4	-2.2	-61.1	4.2	4.6	0.4	9.5	**3.6**	**2.2**	**-1.4**	**-38.9**
Oct	4.3	1.5	-2.8	-65.1	5.5	3.9	-1.6	-29.1	**4.9**	**2.5**	**-2.4**	**-49.0**
Nov	4.1	1.5	-2.6	-63.4	6.8	4.5	-2.3	-33.8	**4.9**	**2.8**	**-2.1**	**-42.9**
Dec	4.7	1.9	-2.8	-59.6	7.2	5.0	-2.2	-30.6	**5.5**	**4.4**	**-1.1**	**-20.0**
Average (Jan–Dec)	4.3	2.3	-2.0	-49.2	6.4	5.6	-0.8	-12.0	**5.6**	**3.9**	**-1.6**	**-32.7**
Average (Mar–Dec)	4.2	1.7	-2.5	-59.0	6.1	5.0	-1.1	-16.0	**5.0**	**3.0**	**-2.0**	**-40.0**

Table A.4: Australian federal and state/territory advice/public health measures related to control of COVID-19 in 2020.

State/territory	Stay at home / Closure of nonessential businesses	Mask wearing
Australian Capital Territory	March to June	
New South Wales	March to June, December	
Northern Territory	March to June	
Queensland	March to June	
South Australia	March to June, November	
Tasmania	March to June	
Victoria	March to June, July to September	From July
Western Australia	March to June	

Appendix Figure A.1: (a) Australian state and territory median annual salmonellosis notifications per 100,000 for 2015 to 2019; (b) percentage decrease in 2020

Figure A.1a

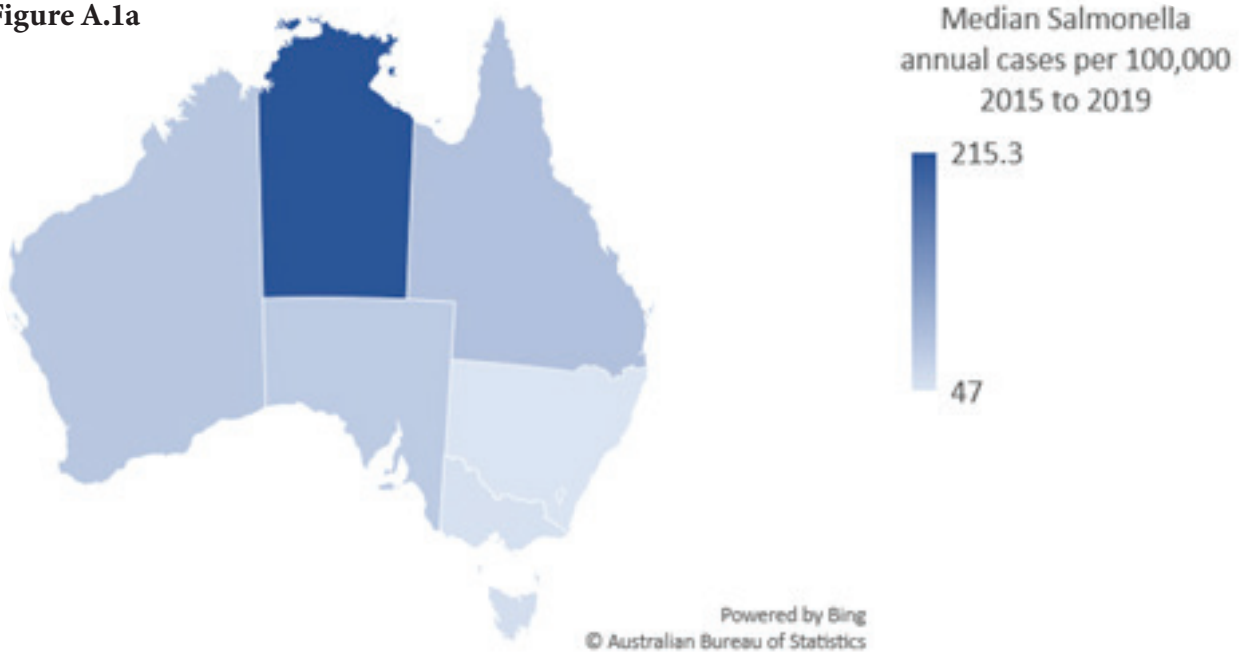

Figure A.1b