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The improving state of Q fever surveillance. A review of Queensland notifications, 2003–2017

Sarah Tozer, Caitlin Wood, Damin Si, Michael Nissen, Theo Sloots, Stephen Lambert

Abstract

Q fever is a notifiable zoonotic disease in Australia, caused by infection with *Coxiella burnetii*. This study has reviewed 2,838 Q fever notifications reported in Queensland between 2003 and 2017 presenting descriptive analyses, with counts, rates, and proportions. For this study period, Queensland accounted for 43% of the Australian national Q fever notifications. Enhanced surveillance follow-up of Q fever cases through Queensland Public Health Units was implemented in 2012, which improved the data collected for occupational risk exposures and animal contacts. For 2013–2017, forty-nine percent (377/774) of cases with an identifiable occupational group would be considered high risk for Q fever. The most common identifiable occupational group was agricultural/farming (31%). For the same period, at-risk environmental exposures were identified in 82% (961/1,170) of notifications; at-risk animal-related exposures were identified in 52% (612/1,170) of notifications; abattoir exposure was identified in 7% of notifications. This study has shown that the improved follow-up of Q fever cases since 2012 has been effective in the identification of possible exposure pathways for Q fever transmission. This improved surveillance has highlighted the need for further education and heightened awareness of Q fever risk for all people living in Queensland, not just those in previously-considered high risk occupations.

Keywords: *Coxiella burnetii*; Q fever; Queensland; surveillance; notifiable disease

Introduction

Q fever, a zoonotic disease caused by the bacterium *Coxiella burnetii*, has a worldwide distribution with the exception of New Zealand and Antarctica.^{1–4} Q fever in humans is contracted by the inhalation of contaminated dust particles or bacterium-containing aerosols shed from infected animals.⁵ It has historically been described as an occupational disease primarily noted in abattoir workers, veterinarians, shearers, tanners, and farmers. However, more current reports suggest that exposures from other sources may have previously been overlooked, or are becoming more common.^{6,7} Several animal species are known to shed *C. burnetii* into the environment and to be potential reservoirs for transmission of Q fever. In Australia, these include livestock, domestic mammals and native wildlife such as wallabies, dingoes and kangaroos.^{6,8–10}

Q fever is a notifiable condition under the National Notifiable Disease list and *Public Health Act (2005)*. Primary infection results in clinical manifestations ranging from no symptoms to acute Q fever. The classical presentation of acute Q fever is an influenza-like illness, fevers, sweats, headaches, less commonly including also other conditions such as hepatitis and pneumonia. Of symptomatic patients, 2% are hospitalised.⁴ Approximately 5% of acute Q fever cases develop chronic Q fever, identified months or years after initial infection. Chronic Q fever presents as endocarditis in 60–70% of cases, or chronic pneumonia with or without hepatitis.⁴ A third disease state, chronic fatigue syndrome (CFS) or post Q fever fatigue syndrome (QFS), was first described in Australian abattoir workers.¹¹ Acute and chronic Q fever are treatable, with doxycycline which is the antibiotic of choice.¹²

In Australia, a whole-cell vaccine against Q fever (Q Vax[®]) was first licensed in 1989, and is manufactured by Seqirus, a subsidiary of CSL limited (Commonwealth Serum Laboratories, Victoria, Australia). The vaccine is recommended for at-risk individuals aged 15 years or older. Workplace Health and Safety (WHS) (*Work Health and Safety Act 2011*) monitor use of the vaccine in order to reduce Q fever acquired in the workplace. Between 2001 and 2006, Q Vax[®] was used in a government-funded vaccination program, the National Q Fever Management Program (NQFMP), with the aim of reducing the incidence of disease.¹³

The aims of this report are to describe the extent and trends of Q fever notification data in Queensland over a 15-year period and to investigate enhanced data following changes to the surveillance of Q fever. From 2012, all public health units in Queensland were instructed to complete an enhanced Q fever surveillance form (Q fever case report form) hence providing more consistent follow-up, including details on risk exposures and animal contacts. Although previous epidemiological reports reviewing the Australian national Q fever notifications have been published,^{7,14} to date there have been no publications reporting Q fever notifications isolated to Queensland, Australia.

Methods

Q fever case notification data, for all confirmed cases in Queensland, between 1 January 2003 and 31 December 2017, were extracted from the Notifiable Conditions System (NOCS)ⁱ by the Communicable Disease Branch of Queensland Health. Confirmed cases fulfilled the national case definition for Q fever notification (Australian Government Department of Health, Australia 2004). This requires either: (i) the detection of *C. burnetii* via culture; (ii) the detection of *C. burnetii* by molecular methods; or (iii) the seroconversion or significant increase in antibody level to Phase II antigen in paired

sera taken in the absence of a recent Q fever vaccination, at least 14 days apart, and screened in parallel.

Data available in the NOCS are compiled from clinical information initiated and provided by diagnostic testing from pathology providers, with follow-up from select individual public health units (PHUs) via case reporting forms. From 2012 onwards, enhanced surveillance data have been captured using laboratory-initiated notifications of Q fever cases and then direct patient contact via the PHU, collecting data with the Q fever case report forms. Individual public health unit investigators conduct this survey either by phone questionnaire or in person. The data are then entered into the NOCS. The data fields extracted for analysis included: year of onset; age; sex; Indigenous status; local government area (LGA) of residence; Hospital and Health Service (HHS) division; occupation; whether hospitalisation was required; exposure to animals; abattoir and environmental related risk exposures; Q fever vaccination status; and awareness of risk for Q fever and Q fever vaccination.

This study provides descriptive analyses, with counts, rates, and proportions of the notification data per year and using three 5-year periods from 2003 to 2017. Estimated Resident Population (ERP) data were attained per year from the Australian Bureau of Statistics for populations for Queensland and within LGAs.¹⁵ Queensland data were also analysed according to HHS divisions of Queensland Health. Population data for HHS were obtained directly from the open access Queensland Government website.¹⁶ The estimated notification rate per LGA or HHS was calculated for each year accordingly:

$$\text{Q fever notification rate} = \frac{\text{total notifications}}{\text{estimated resident population}} \times 100,000$$

Where the notification rate for multiple years was calculated, the average ERP for the total period was used as an estimated denominator.

i <https://www.health.qld.gov.au/clinical-practice/guidelines-procedures/diseases-infection/notifiable-conditions/register>

Where possible, Queensland state Q fever data were compared to Australian national Q fever data, sourced from the National Notifiable Diseases Surveillance System.¹⁷

Data were cleaned and analysed using the software Microsoft Excel 2011 and R.¹⁸ Surveillance data included a free text field for place of work. Data captured in this field were aggregated into work group categories: see the Appendix for details of groupings (Table A.1). Visualisation of the spatial distribution of case notification counts or rates per HHS and LGA was performed by creating choropleth maps in Q GIS.¹⁹

Results

Q fever notification counts and rates by age and sex

Between 2003 and 2017, a total of 2,838 cases of Q fever were notified in Queensland. Annual case notification rates ranged from 3.0 to 5.1 per 100,000 population. Annual notification counts and rates for Queensland and Australia have been presented together in Figure 1. Although the notifications fluctuated over this study period, the annual Queensland notification rate remained approximately double the national notification rate. For this period, Queensland accounted for 43.1% (2,838/6,591) of all the national Australian Q fever notifications while the population of Queensland represented only 19.6% of the Australian population during this time frame.

Of the 2,838 Q fever cases notified in Queensland, 2,231 specified their Indigenous status. Of these respondents, 5.5% (n = 123) were Aboriginal and/or Torres Strait Islander Australians. This percentage remained stable over the entire study period.

In Queensland, for the entire study period, age and gender were recorded for every case record. Q fever was notified in all age groups. The median age of cases was 46 years (interquartile range (IQR): 33–57). The median age for males was 45 years (IQR 32–57) and for females 48 years (IQR

36–58). Across the entire study period, the highest crude case notifications were in the 55–59 years age group, followed by the 40–44 years age group. During the 15-year period analysed, 117 notifications occurred in children aged ≤ 15 years, with an increase in notifications occurring as age increased.

Overall, 74.6% (2,118/2,838) of all notifications were recorded as male, and 25.4% (720/2,838) were female. When stratified by gender and age (Figure 2), males in the 40–44 age group had the highest number of cases in Queensland over the study period. Q fever occurred more frequently in males than females with an overall ratio (M:F) of 3.0:1 (Table 1).

From 2003 to 2017 the proportion of notifications recorded as female remained relatively similar (21.5% in 2003, 23.3% in 2017), however there was a noticeable increase from 18.1% in 2006 to a peak of 29.6% in 2008. From 2008 onwards, the proportion remained largely stable, gradually decreasing to 23.3%. A summary of Queensland notification counts and average annual notification rates/100,000 population by gender and age groups is presented, aggregated into three 5-year periods, in Table A.2 (Appendix).

Distribution of Q fever notifications, by HHS and LGA

Over the full 15 year study period 2003–2017, 22.0% (n = 625/2,838) of all Queensland notifications were from the Darling Downs HHS area, with 13.0% (n = 368/2,838) from the South West HHS, and 9.2% (n = 261/2,838) from Townsville HHS (Table 2 and Figure 3). However, the highest average annual Q fever case notification rate/100,000 population over this period was for the South West HHS (95.5), then Central West HHS (52.5) followed by the Darling Downs HHS divisions (15.9).

Cumulative Q fever notification rates, aggregated by residential LGA, for consecutive 5-year periods are presented in Figure 4 to show geographical distribution of Q fever notifications across Queensland. For each period, the LGA

Figure 1: Q fever notifications and annual rates/100,000 population for Queensland and Australia, by year, 2003–2017

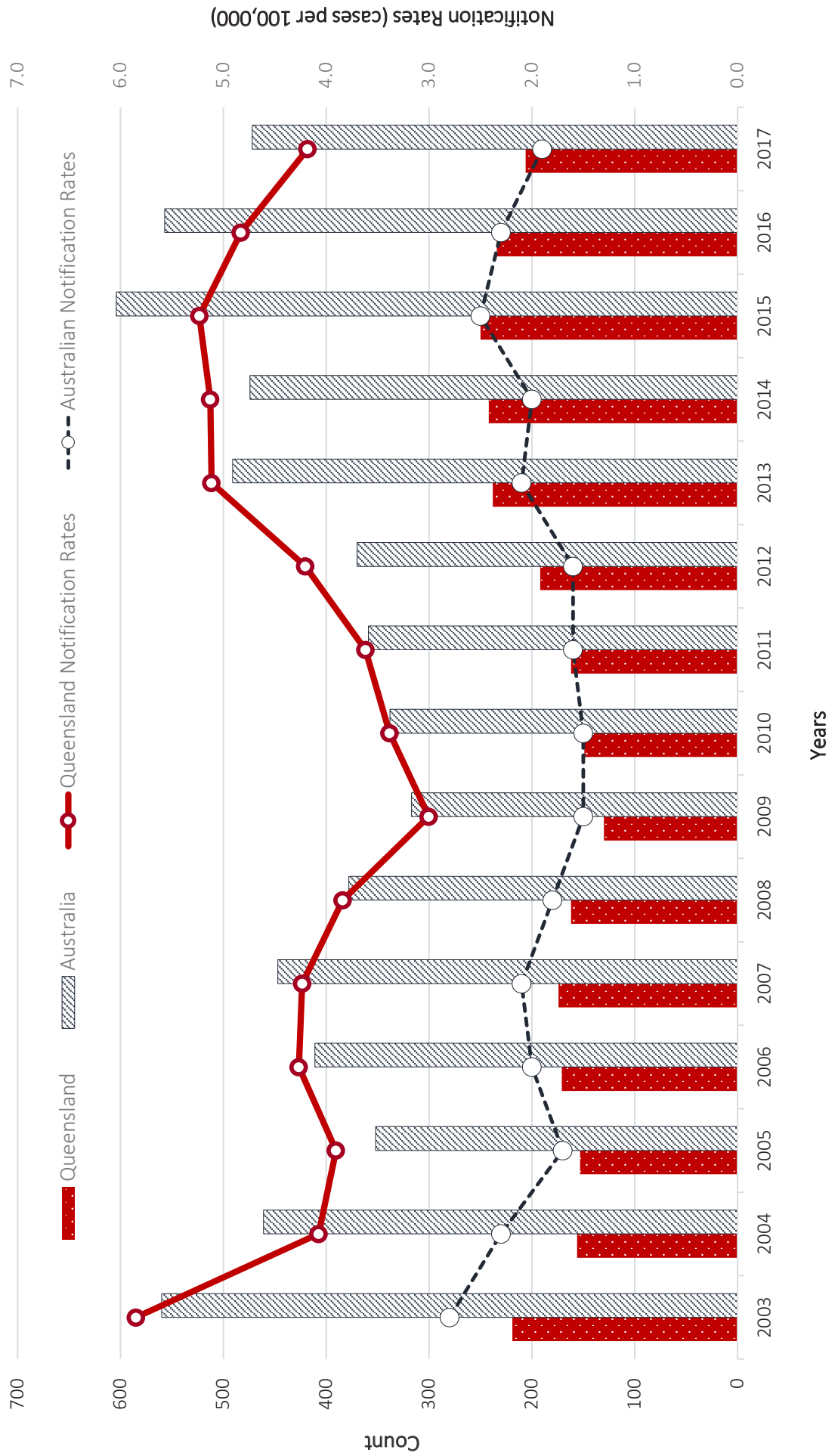


Table 1: Confirmed Q fever cases in Queensland between 2003 and 2017,^a summarised by 5-year periods and for the entire period

	2003–2007	2008–2012	2013–2017	Overall 2003–2017
No. cases	873	795	1,170	2,838
No. of male cases	669 (76.6%)	575 (72.3%)	874 (74.7%)	2,118 (74.6%)
Notification rate (males)	6.76	5.19	7.31	6.43
No. of female cases	204 (23.4%)	220 (27.7%)	296 (25.3%)	720 (25.4%)
Notification rate (females)	2.05	1.98	2.44	2.17
Male: female ratio	3.3:1	2.6:1	3.0:1	3.0:1
Median age (IQR)	43 (31–55)	46 (34–57)	48 (34–59)	46 (33–57)
Median male age (IQR)	42 (30–54)	46 (33–57)	48 (34–60)	45 (32–57)
Median female age (IQR)	46 (34–57)	48 (37–58)	49 (36–58)	48 (36–58)

a Notification rates were calculated as an annual average notification / 100,000 population. Numbers inside parentheses are the percentage of total cases for that period.

of Mareeba had the highest 5-year case notification rate. Other LGAs that consistently had high case notification rates for the study period were Balonne, Paroo and Murweh.

Hospitalisation and work absences due to Q fever

During 2003–2017, hospitalisation data were recorded for 2,123/2,838 Q fever patients, of which 53.3% (1,134/2,123) required hospitalisation. This figure represents 40.0% of the total Q fever cases for this period. Hospitalised patients had a length of stay ranging from 1 to 57 days. Of patients that were hospitalised, the median stay was 5 days (mean = 6.3 days; IQR 3–7 days). Collectively, days of hospitalisation for these patients amounted to 6,336 days. Number of days absent from work due to illness was recorded for 947 patients (33.3%), with 864 (30.4%) requiring at least 1 day absent. Number of days absent per case ranged from 1 to 330 days, median 10 days (mean = 14.5 days; IQR 5–20 days).

Occupational groups

For the years 2003–2012, the majority of notified cases (74%; 1,239/1,668) had either unanswered or unidentifiable responses for the free-text

field describing their occupation. For the years 2013–2017, most cases (89%; 1,044/1,170) had a response entered for occupation; however, 26% (270/1,044) of these were classed as unknown, according to the reclassification described in the Appendix (Table A.1).

Table 3 shows a summary of Q fever cases per occupational category for the years 2013–2017. Of the 774 cases that could be reclassified into occupational categories, 31% were involved in agricultural or farming activities, 20% were unemployed or retired, 13% involved working in a trade. Of these cases with identifiable occupational groups, approximately 49% (377/774) of cases would be considered at-risk occupational groups within Australia.²⁰

At-risk exposures within one month prior to onset of Q fever

For the study period 2003–2017, at-risk exposure data fields for Q fever notifications in Queensland were summarised into three categories: animal-related; environmental; and abattoir (Table 4). Details of at-risk exposures under these three categories are presented in Table 5, Table 6, and Table 7; note that multiple exposures can be recorded for an individual case. Identification of

Figure 2: Summary of Queensland Q fever notifications by sex and 5-year age groupings, 2003–2017

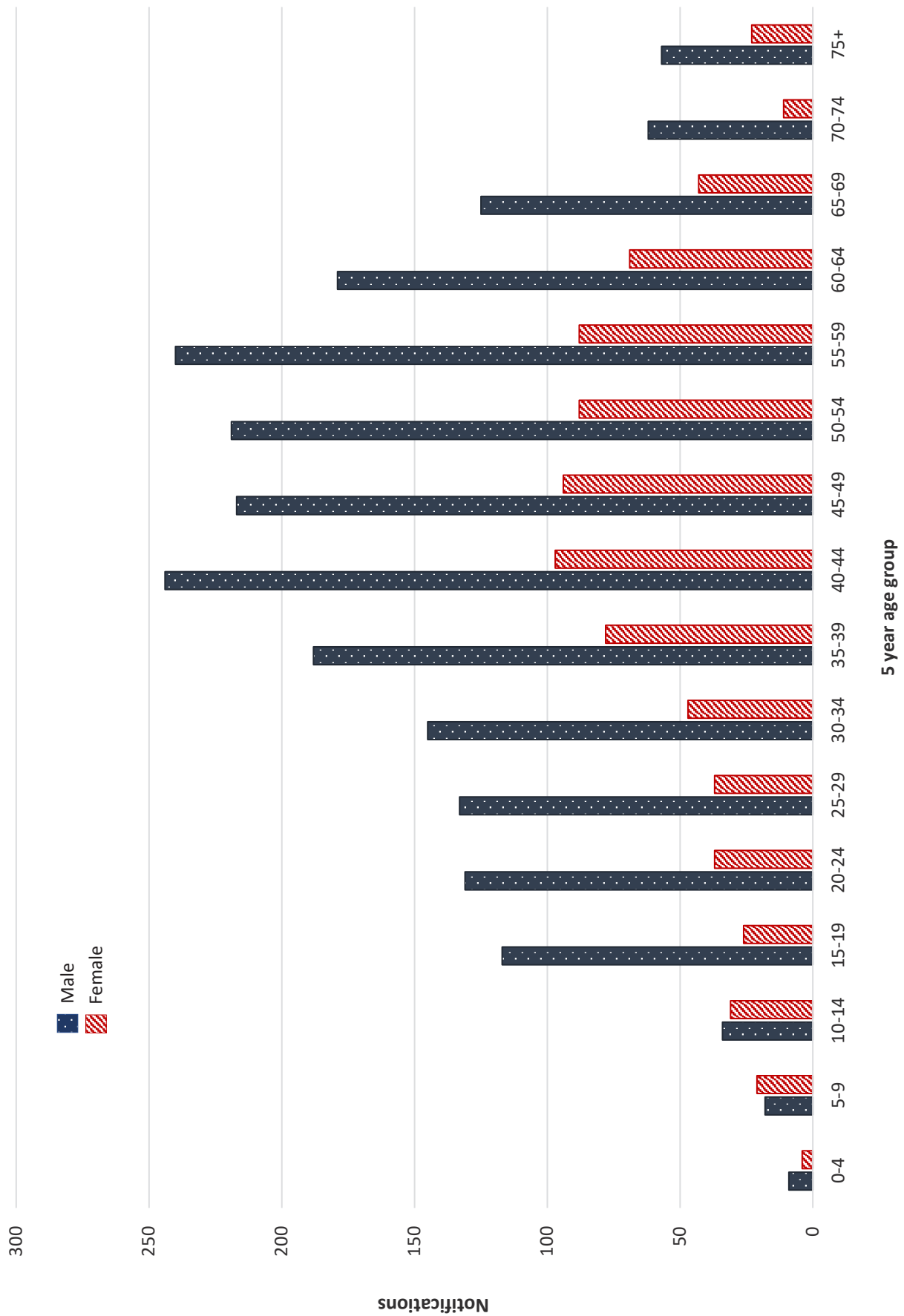


Table 2: Notifications of Q fever by Hospital and Health Service (HHS) of residence, 2003–2017, Queensland

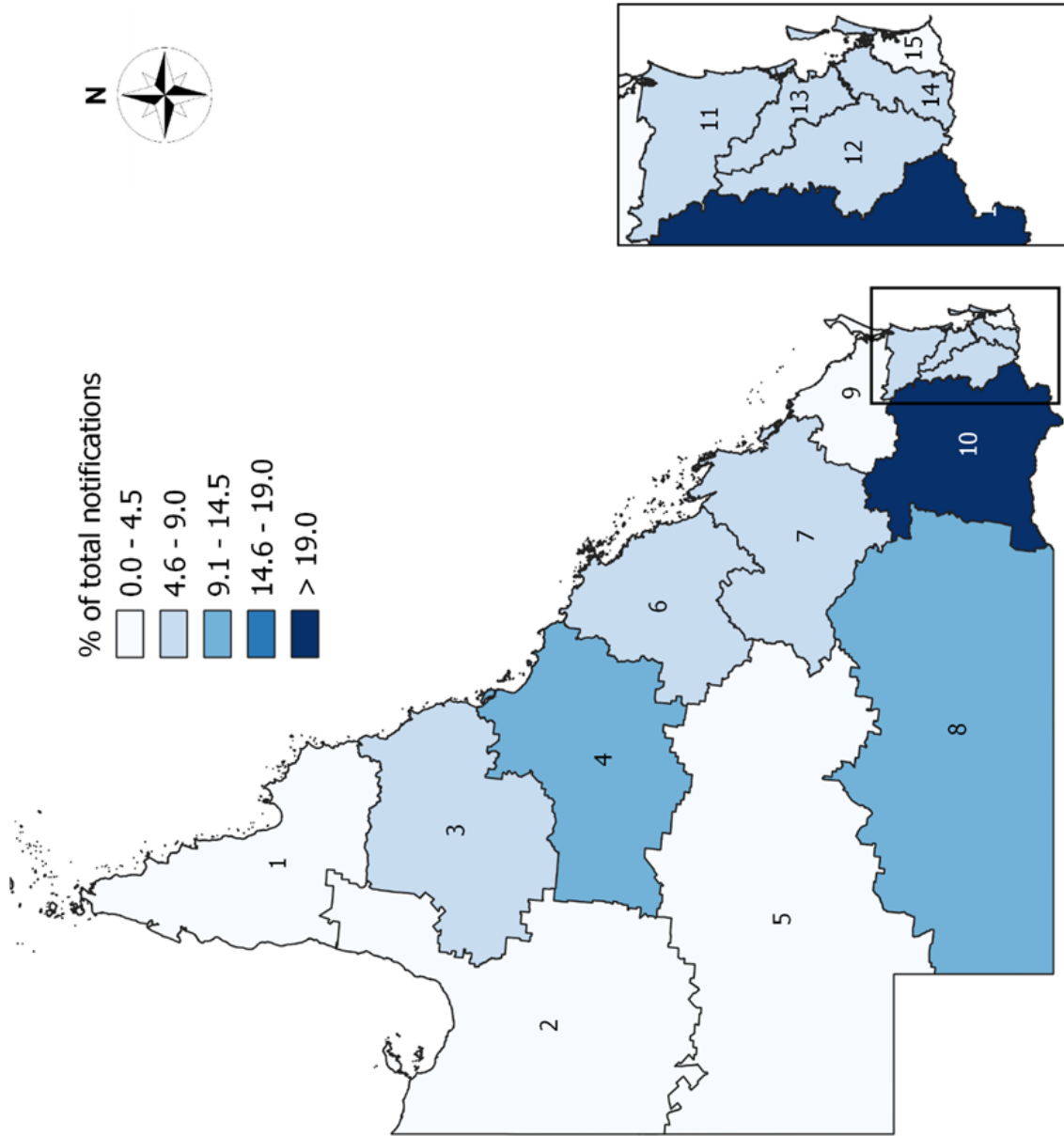
Hospital Health Service division	Total No. of notifications	% of all Qld cases	% hospitalised	Notification rate/100,000 population
Darling Downs	625	22.0	33.1	15.9
South West	368	13.0	24.7	95.5
Townsville	261	9.2	47.9	7.8
Metro South	234	8.3	47.0	1.5
Cairns and Hinterland	225	7.9	31.6	6.5
West Moreton	216	7.6	50.0	6.1
Sunshine Coast	170	6.0	36.5	3.2
Mackay	161	5.7	43.5	6.5
Central Queensland	141	5.0	50.4	4.6
Metro North	131	4.6	45.8	1.0
Gold Coast	123	4.3	52.8	1.6
Central West	94	3.3	48.9	52.5
Wide Bay	70	2.5	58.6	2.3
Torres and Cape	13	0.5	30.8	3.6
North West	5	0.2	40.0	1.1
Interstate/international	1	0.0	100.0	–
Total Qld notifications	2,838	100	40.0	4.9

exposures that may increase risk of disease are described in reports by Queensland Government Workplace Health and Safety,²¹ or in the Communicable Diseases Network Australia (CDNA) Q fever National Guidelines for Public Health Units.²⁰ Additional data for any animal contact, that may not involve ‘at-risk’ activities, were only available from 2012 onwards, hence are presented for 2013–2017 only.

For the period 2013–2017, from the risk exposures detailed in Table 6, environmental exposures were identified in 82% (961/1,170) of all Q fever notifications in Queensland, with 60% of total cases (703/1,170) reporting exposure to dust from paddocks or animal yards in the one month prior to disease onset. Fifty-eight percent of total cases (684/1,170) responded ‘yes’ to living or working within 300 metres of bush/scrub/forest areas. This was followed by living or working

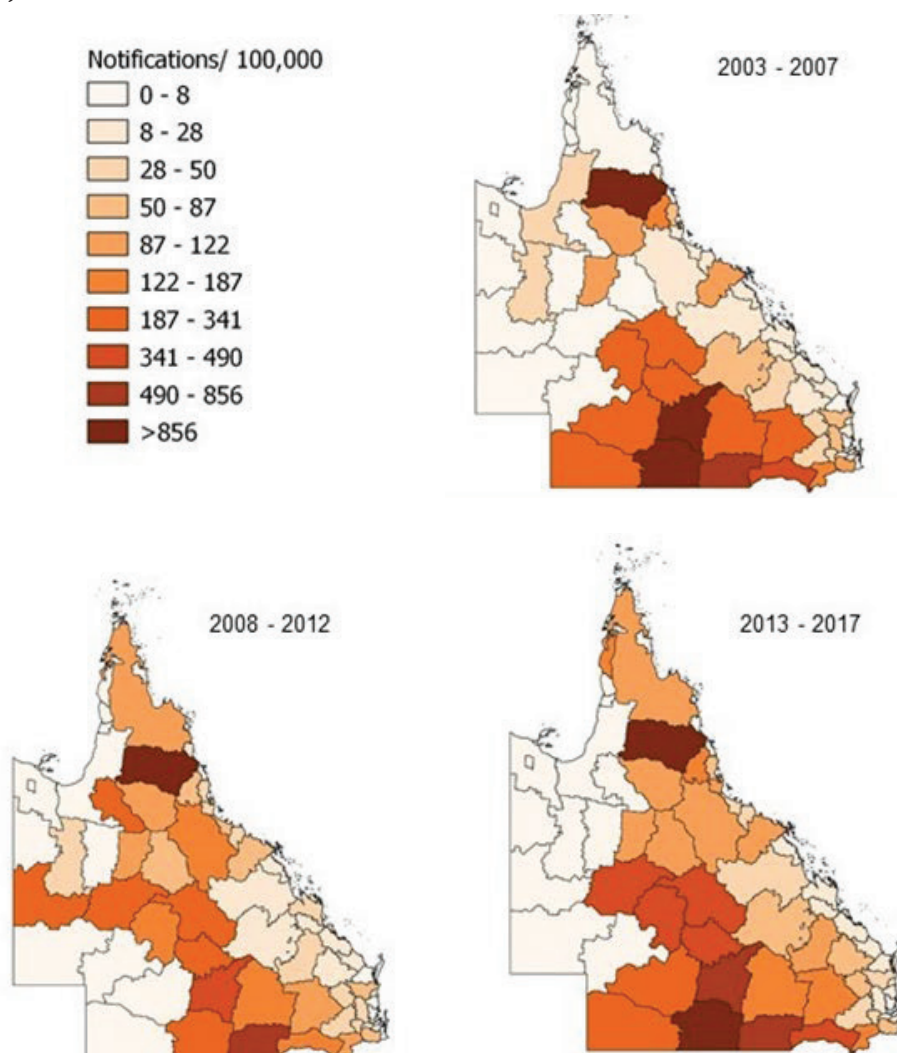
within 1 kilometre of an abattoir/animal grazing land or saleyards, indicated in 52% of total cases (613/1,170). For the same period, at-risk animal-related exposures (as detailed in Table 5) were evident in 52% (612/1,170) of notified Q fever cases in Queensland. The most frequent activity was using animal manure or fertiliser, followed by assisting or observing in an animal birthing. Of those who assisted in animal birthing, 65% (131/199) specified cattle. Of 1,170 cases notified, 7% (n = 85) reported some abattoir exposure in the month prior to disease onset, including: working inside or on the grounds of an abattoir; working as a contractor; or visiting an abattoir (Table 8).

Figure 3: Q fever case notifications (%) for Queensland by Hospital Health Service divisions,^a 2003–2017



^a Numbers correspond to HHS divisions: 1 = Torres and Cape; 2 = North West; 3 = Cairns and Hinterland; 4 = Townsville; 5 = Central West; 6 = Mackay; 7 = Central Queensland; 8 = South West; 9 = Wide Bay; 10 = Darling Downs; 11 = Sunshine Coast; 12 = West Moreton; 13 = Metro North; 14 = Metro South; 15 = Gold Coast.

Figure 4: Q fever notification rates (per 100,000 population) aggregated by residential LGA for 5-year periods, from 2003 to 2017



Additional animal contact surveillance data (2013–2017)

From 2013–2017, 99.9% of cases reported at least one direct animal contact in the one month prior to onset of disease (1,169/1,170). A summary of exposure to specific animals is presented in Table 8. Caution should be taken when interpreting this data, as it includes multiple animal co-exposures and these exposures were not confirmed as the source of Q fever. The most common animal contacts recorded were dogs (n = 661; 56.5%) followed by native wildlife (n = 619; 52.9%) then cattle (n = 569; 48.6%).

Q fever vaccination status and subjects' awareness of risk of contracting disease

A summary of the Queensland Q fever notification subjects' awareness, of the risk for contracting Q fever and of the Q fever vaccine, is presented in Table 9. From those who responded, 27% of cases from 2003 to 2007 were aware they were at risk of Q fever; this reduced to 21% for the periods 2008–2012 and 2013–2017. For awareness of the Q fever vaccine, the crude proportion of cases who were aware decreased slightly from 45% (2003–2007) to 42% (2012–2017). However, it is clear that response rate for surveillance fields increased over these periods, hence a comparison of crude measures may be unreliable. Over the entire study period, 75% (2,137/2,838) of cases had vaccination status

Table 3: Q fever cases in Queensland (2013–2017) by occupational category

Occupational categories	No. cases (%)
Agricultural/farming ^a	236 (30.5%)
Unemployed/retired	153 (19.8%)
Trades	104 (12.8%)
Teaching or student	46 (5.9%)
Transport ^a	43 (5.6%)
Meat processing ^a	40 (5.2%)
Gardening/lanscaping ^a	37 (4.8%)
Administrative	37 (4.8%)
Health/hospitality	31 (4.0%)
Mining	19 (2.5%)
Services	12 (1.6%)
Wildlife ^a	11 (1.4%)
Veterinary/ companion animals ^a	10 (1.3%)

a Occupational groups that are considered 'high risk' for Q fever within Australia.

b Numbers in parentheses are column percentages

recorded. Of these, 92% had not been previously vaccinated, 3% were listed as being vaccinated for Q fever and 5% were unknown.

For the years 2013–2017, 86% of cases were linked to at least one previously described 'at-risk' exposure during the 1 month prior to disease onset. (Table 4) However, for the same period, only 21% of cases were aware that they might be at risk of Q fever (Table 9). Data for those who responded yes to 'at-risk' exposures have been cross-referenced with the data field for awareness of Q fever risk. The 'at-risk' exposure category with the least awareness was environmental-related and the most awareness was for the notified cases who had abattoir-related exposure shown in Table 10.

Discussion

Overall, for this study period, Queensland accounted for approximately 43% of the national Q fever notifications. Queensland continues

to report more Q fever cases than other states within Australia. The fluctuations in annual Q fever notification rates for Queensland seen over time may be due to the influence of multiple factors. These may include the end of the NQFMP in 2006, heightened awareness by general practitioners, changes in surveillance, testing and reporting of case notifications and the occurrence of outbreaks.^{4,7,22}

Other studies have reported that Q fever predominately occurs in males of working age, with highest notification rates in the 40–59 years age group,^{7,14,23,24} this trend remains true for the Queensland data analysed in this study. It was previously reported, from Australian national data, that the average age of case notifications and the proportion of female cases had increased over time from 1991 to 2014.⁷ In the current study, the average age of notified cases was seen to be increasing over time, however, the proportion of notifications recorded as female remained relatively constant. There was a peak identified in the proportion of female notifications immediately following the end of the NQFMP; this could be explained by a reduction in male notifications following the success of the program, which was targeted at farming and meat-processing industries.⁷

The overall Q fever notification rate in Queensland was approximately double the Australian national notification rate; however, when examining the notification rates by LGA and HHS, it is clear that some geographic regions within Queensland reported rates consistently above the average. The distribution of Q fever seems to vary between and within countries, likely due to the wide range of animal reservoirs, differences in *C. burnetii* strains and environmental factors that are not yet completely understood.²⁵ However, reporting biases may also exist with notification data, due to underreporting in areas with less access to testing and reduced Q fever awareness. The geographical distribution of Q fever within Queensland requires more in-depth spatial and/or spatio-temporal analysis to identify clustering of disease across space and time and to identify potential risk factors that may be linked to geographical hotspots.

Table 4: Summary of at-risk exposure groups for Q fever cases in Queensland, by 5-year period

	5-year time frames ^a			
	Overall study period	2003–2007	2008–2012	2013–2017
Total number of Q fever cases	2,838	873	795	1,170
<i>Exposures during 1 month prior to onset of illness^b</i>				
Abattoir related exposure				
No. with any abattoir exposure	138 (5%)	18 (2%)	35 (4%)	85 (7%)
Animal-related exposures				
No. with any animal-related exposure	1,240 (44%)	329(38%)	299 (38%)	612 (52%)
Environmental exposure				
No. with any environmental exposure	1,530 (54%)	109 (12%)	460 (58%)	961 (82%)
No. cases with any exposure to a putative risk factor ^c	1,995 (70%)	512 (63%)	481 (61%)	1,002 (86%)
No. cases without information or no reports of risk exposures [±]	807 (28%)	325 (37%)	314 (39%)	168 (14%)

a Numbers in parentheses are column percentages

b Multiple exposures can be recorded for the same individual

c As per definition of persons at increased risk of disease as reported by Queensland Government Workplace Health and Safety or in the Communicable Diseases network Australia (CDNA) Q fever National Guidelines for Public Health Units 20

Table 5: Details of at-risk animal-related exposures for Queensland Q fever cases during the one month prior to disease onset

	Time period					
	2003–2007		2008–2012		2013–2017	
Total number of Q fever cases	873		795		1,170	
<i>Total animal related exposures (% of column)</i>	329 (38%)		299 (38%)		612 (52%)	
	Responders	Responders positive for exposure	% positive of total cases	Responders	Responders positive for exposure	% positive of total cases
worked with animal manure/fertiliser	524	41 (8%)	5%	480	145 (30%)	18%
worked with straw or animal bedding	519	18 (3%)	2%	483	92 (19%)	12%
observing or assisted in animal birthing	516	144 (28%)	16%	482	121 (25%)	15%
involved in slaughtering, skinning or meat processing	522	27 (5%)	3%	483	68 (14%)	9%
involved in shooting/hunting	525	18 (3%)	2%	481	45 (9%)	6%
attended a saleyard or animal show	520	20 (4%)	2%	474	53 (11%)	7%
worked with wool	521	10 (2%)	1%	487	26 (5%)	3%
				1,009	353 (35%)	30%
				1,004	223 (22%)	19%
				1,015	199 (20%)	17%
				1,010	161 (16%)	14%
				1,007	156 (15%)	13%
				1,006	127 (13%)	11%
				1,019	70 (7%)	6%

Table 6: Details of environmental exposures for Queensland Q fever cases during the one month prior to disease onset

	Time period					
	2003–2007		2008–2012		2013–2017	
Total number of Q fever cases	873		795		1,170	
<i>Environmental exposure (% of column)</i>	109 (12%)		460 (58%)		961 (82%)	
	Responders	Responders positive for exposure	% positive of total cases	Responders	Responders positive for exposure	% positive of total cases
exposure to dust from paddock or animal yards	504	68 (13%)	8%	492	316 (64%)	40%
live/work within 300 m of bush/scrub/forest area	496	70 (13%)	8%	487	317 (65%)	40%
live/work within 1 km of abattoir/animal grazing or saleyards	501	63 (12%)	7%	482	254 (53%)	32%
lived on a farm	531	51 (10%)	6%	493	215 (44%)	27%
exposure to livestock transport	521	50 (10%)	6%	486	206 (42%)	26%
had contact with untreated water	527	50 (10%)	6%	487	147 (30%)	18%
visited a farm	522	62 (12%)	7%	488	191 (41%)	24%
laundered clothes from someone who works with animals	521	27 (5%)	3%	488	123 (25%)	15%
contact with a Q fever infected person	528	9 (2%)	1%	493	26 (5%)	3%
consumed unpasteurised milk or milk products	527	12 (2%)	1%	496	41 (8%)	5%
	Responders	Responders positive for exposure	% positive of total cases	Responders	Responders positive for exposure	% positive of total cases
				1,041	703 (68%)	60%
				1,039	684 (66%)	58%
				1,041	613 (59%)	52%
				1,016	488 (48%)	42%
				1,018	516 (51%)	44%
				1,028	480 (47%)	41%
				723	310 (43%)	26%
				1,020	262 (26%)	22%
				1,040	56 (5%)	5%
				1,042	56 (5%)	5%

Table 7: Details of abattoir exposures for Queensland Q fever cases during the one month prior to disease onset

	Time period			
	2003–2007	2008–2012	2013–2017	
	873	795	1,170	
Total number of Q fever cases				
<i>Abattoir related exposure (% of column)</i>	18 (2%)	35 (4%)	85 (7%)	
	Responders	Responders	Responders	Responders positive for exposure
				% positive of total cases
worked inside the abattoir	133	269	1,011	67 (7%)
worked in the grounds of the abattoir	80	91	333	26 (8%)
visited abattoir	83	86	338	23 (7%)
contract worker at an abattoir	81	80	321	9 (3%)
				% positive of total cases
				6%
				2%
				2%
				1%

Table 8: Direct animal and insect contact in the one month prior to onset of Q fever, 2013–2017

Animals and insects	Responded yes	% of total cases (n = 1,170)
dogs	661	56.5%
Australian native wildlife	587	50.2%
<i>kangaroos</i>	418	
<i>small marsupials</i>	169	
cattle	569	48.6%
cats	332	28.4%
sheep	204	17.4%
ticks	197	16.8%
feral pigs	156	13.3%
domestic goat	109	9.3%
domestic pigs	80	6.8%
feral goat	67	5.7%
horses	66	5.6%
other	215	18.4%

Table 9: Details of awareness of risk and vaccination from notified Q fever cases in Queensland, by 5-year periods

	Period		
	2003–2007	2008–2012	2013–2017
Total number of Q fever cases	873	795	1,170
Aware that they were at risk of Q fever			
No. of responders (response rate)	530 (61%)	490 (62%)	1,050 (90%)
Yes	142 (27%)	103 (21%)	220 (21%)
No	330(62%)	357 (73%)	774 (74%)
Unknown	58 (11%)	30 (6%)	56 (5%)
Aware of Q fever vaccination			
No. of responders (response rate)	526 (60%)	488 (61%)	1,048 (90%)
Yes	239 (45%)	216 (44%)	445 (42%)
No	213 (40%)	239(49%)	543 (52%)
Unknown	74 (14%)	33(7%)	60 (6%)

Table 10: Personal awareness of risk of Q fever, in cases who responded yes to an ‘at-risk’ exposure during the one month prior to disease onset, 2013–2017

“At-risk” exposure in 1 month prior to disease onset ^a	Personal awareness of risk			Total
	No	Yes	Unknown	
Environmental	698 (74%)	208 (22%)	37 (4%)	943
Animal	391 (59%)	194 (29%)	18 (3%)	603
Abattoir	42 (50%)	36 (43%)	6 (7%)	84

a Multiple exposures can be recorded for the same individual. Definitions of persons at increased risk of disease as reported by Queensland Government Workplace Health and Safety or in the Communicable Diseases Network Australia (CDNA) Q fever National Guidelines for Public Health Units.²⁰

When examining the surveillance data field responses across this study period, it was clear that since the implementation of enhanced Q fever surveillance in 2012, there has been an improvement in the overall response rate to survey questions. This has allowed ‘at-risk’ exposures that are likely sources of Q fever transmission to be identified for a greater number of cases. Improved Q fever surveillance, as is evident in Queensland, will allow improved planning for educational campaigns and efforts to increase vaccine uptake so as to prevent a greater number of Q fever cases. In 2018, in order to provide nationally consistent advice and guidance to public health units, Q fever reporting was included within the Series of National Guidelines (SoNG), including a national Case Reporting Form. This has allowed comparable data to be collected across multiple states so that the epidemiology of Q fever can be analysed accurately at a national and international level.

The most frequent occupational group for the 2013–2017 period, from respondents with an identifiable response, was agricultural/farming, followed by retired or unemployed. It was interesting that just over 5% of notifications worked in meat processing. For this period, 51% of cases would be considered to be in a classical at-risk occupational group for Q fever in Australia and therefore such cases should be preventable with correct vaccination.²⁰ It highlights the poor uptake of Q Vax[®] or the knowledge gap that still exists in some at-risk occupations. With the

remaining 49% of cases not having an at-risk occupation, this study reiterates that occupation is a poor proxy for Q fever risk exposure. This is in line with a New South Wales report for Q fever notifications during a similar period.²³ We acknowledge that there were difficulties analysing occupation data, as many entries were unidentifiable; included area codes, specific organisation names or suburbs rather than an occupation. However, the quality of data improved from 2012 onwards, likely because of the change in survey protocol and enhancement of Q fever surveillance.

This study found that approximately 7% of Queensland Q fever notifications have reported abattoir exposure in the 1 month prior to illness. This includes working in or on the grounds of the abattoir, working as a contractor of an abattoir or visiting an abattoir. This figure is much lower than what has been reported for Victoria, Australia, where 25% of notifications were still related to abattoir exposures for the years 2009–2013.²⁴ This is likely because in Queensland, the abattoir workforce is currently well educated on the risks of Q fever and are mandated to be checked for prior exposure and vaccinated prior to commencing work. Hence, this data does not suggest a reduced risk of Q fever in the meat processing industry in Queensland, rather an improvement in Q fever prevention within this industry.

This study has identified, with improved surveillance data, that the most frequent at-risk exposures for Q fever notifications in Queensland (2013–2017) were environmental exposures: exposure to dust from animal paddocks, living within 300 metres of bush/scrub/forest and living or working within 1 kilometre of an abattoir. The transmission of Q fever to humans from environmental dispersal of *C. burnetii* from animal holdings and abattoirs has been documented in a review article.²⁶ Although that review did not include any Australian publications, it is likely that similar scenarios exist within Australia; local investigations are warranted to assess the risk of airborne geographical dispersal of *C. burnetii* to Queensland communities, from wildlife areas, livestock holdings and abattoirs.

It has been previously reported that only 2% of acute Q fever cases require hospitalisation;⁴ however, this study showed that 40.0% of the total Q fever cases spent at least one day in hospital. This is similar to a report from New South Wales, Australia, where 46.5% of cases from 2011–2015 were hospitalised. Without current comparable nationwide data, it is uncertain whether these hospitalisation rates are consistent throughout Australia or are higher for these two states. However, it may be worth noting that combined, Queensland and New South Wales account for approximately 80% of all national Q fever notifications.⁷

Overall, surveillance of Q fever notifications in Queensland has improved since the development of the case report form and implementation of case follow-up by public health units in 2012. This enhanced surveillance revealed that 86% of notified cases had an at-risk exposure (environmental, animal or abattoir) in the one month prior to disease onset and 99% of notifications had animal contact. Q fever acquired from known at-risk exposures should be preventable with the use of vaccination. Greater awareness of the potential risk through indirect environmental exposures should be a focus to help reduce the impact of Q fever on public health in Queensland.

Ethics approvals

This work was approved by Children’s Health Queensland Ethics Committee.

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Appendix: supplementary tables

Table A.1: NOCS field 'place of work' free text words aggregated into new categories

New field	Classification	Aggregated free text terms
Occupation	Administrative	sales / reception / admin / recruit / office / retail / survey / account / book / politic / lawyer
	Agricultural / farming	farm / grazier / livestock / cattle / sheep / horse / camel / goat / pig / shear / muster / stockman / station / farrier / fish / wool / drover / grower / cotton / fruit / cane
	Gardening / landscape	landscape / lawn / grass / mow / grounds / earth / garden / aborist
	Health / hospitality	health / therapist / beaut / carer / nurse / doctor / hosp / bar / tavern
	Meat industry	abattoir / meat / butcher / pet food / specific names of abattoirs in Queensland
	Mining	miner / mining / mine
	Services	army / navy / airforce / soldier / barrack / police / RAAF / veteran
	Teaching / student	student / college / school / teach / specific names of universities in Queensland
	Trades	handy / mechanic / maintain / caretaker / glazier / courier / tile / machin / baker / build / construction / paint / boiler / apprentice / concrete / builder / labourer / cabinet / electrician / fencer
	Transport	truck / transport / drive / rail
	Unemployed / retired	unemployed / retired / pension
	Veterinary	vet / anim / cat breeder / breeder / dog
	Wildlife	wild / roo / shoot / ranger
	Unknown	Any numbers / unknown / not stated

Table A.2: Queensland Q fever notifications aggregated into three 5-year periods by age grouping and sex from 2003–2017

Sex/Age group	2003–2007		2008–2012		2013–2017	
	Count	average annual rate/ 100,000	Count	average annual rate/ 100,000	Count	average annual rate/ 100,000
Queensland Population						
0–4	4	0.31	2	0.13	7	0.44
5–9	9	0.67	7	0.49	16	0.99
10–14	22	1.57	14	0.96	19	1.25
15–19	46	3.38	48	3.19	54	3.51
20–24	58	4.16	41	2.59	58	3.42
25–29	57	4.34	43	2.70	70	4.05
30–34	63	4.39	49	3.30	70	4.17
35–39	94	6.57	61	3.82	80	5.12
40–44	111	7.56	98	6.29	113	6.76
45–49	94	6.72	94	6.09	126	7.87
50–54	93	7.21	88	6.09	132	8.43
55–59	88	7.36	103	7.92	137	9.50
60–64	62	6.67	76	6.41	110	8.57
65–69	37	5.19	38	4.17	93	8.02
70–74	15	2.65	12	1.80	46	5.36
75+	20	1.86	21	1.73	39	2.76
Total	873	4.45	795	3.61	1,170	4.89
Male						
0–4	2	0.30	2	0.26	5	0.61
5–9	7	1.02	5	0.68	6	0.72
10–14	11	1.53	11	1.47	12	1.54
15–19	39	5.61	35	4.55	43	5.47
20–24	45	6.36	35	4.36	51	5.94
25–29	51	7.72	28	3.47	54	6.25
30–34	52	7.30	40	5.41	53	6.36
35–39	80	11.30	47	5.93	61	7.90
40–44	84	11.59	75	9.71	85	10.30
45–49	71	10.26	58	7.60	88	11.22
50–54	67	10.40	61	8.53	91	11.83
55–59	59	9.75	79	12.16	102	14.38
60–64	46	9.73	48	8.01	85	13.41

	2003–2007		2008–2012		2013–2017	
Sex/Age group	Count	average annual rate/ 100,000	Count	average annual rate/ 100,000	Count	average annual rate/ 100,000
65–69	28	7.76	26	5.67	71	12.25
70–74	13	4.68	10	3.00	39	9.14
75+	14	3.12	15	0.29	28	4.50
Total	669	6.84	575	5.24	874	7.35
Female						
0–4	2	0.32	0	0.00	2	0.26
5–9	2	0.31	2	0.29	10	1.27
10–14	11	1.61	3	0.42	7	0.95
15–19	7	1.05	13	1.77	11	1.46
20–24	13	1.90	6	0.77	7	0.84
25–29	6	0.92	15	1.91	16	1.85
30–34	11	1.52	9	1.21	17	2.01
35–39	14	1.94	14	1.74	19	2.40
40–44	27	3.63	23	2.92	28	3.30
45–49	23	3.26	36	4.61	38	4.66
50–54	26	4.03	27	3.70	41	5.15
55–59	29	4.91	24	3.68	35	4.78
60–64	16	3.50	28	4.77	25	3.85
65–69	9	2.55	12	2.65	22	3.80
70–74	2	0.70	2	0.60	7	1.62
75+	6	0.95	6	0.86	11	1.39
Total	204	2.08	220	2.00	296	2.46