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Hospital-based surveillance of respiratory syncytial virus in Central Queensland

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Hospital-based surveillance of respiratory syncytial virus in Central Queensland

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Abstract

Background

Respiratory syncytial virus (RSV) is a leading cause of acute lower respiratory tract infections, especially in infants and young children globally. Despite its impact, RSV testing and epidemiological data remain limited, particularly in regional Australia. Central Queensland, with its subtropical climate, provides a unique setting in which to study RSV trends, testing patterns, and associated hospital burden.

Methods

This study used hospital-based data to analyse RSV-related hospitalisations and testing from Central Queensland. Data were collected retrospectively between 2018 and 2021 and prospectively between 2022 and 2023. Eligible cases included individuals presenting to or admitted at any hospitals in Central Queensland with laboratory-confirmed RSV or RSV-related diagnoses based on ICD-10-AM codes. The analysis focused on RSV-related hospital admissions and hospitalisation outcomes. Incidence rate ratios (IRR) for hospitalisation rates between the two periods were calculated.

Results

Between 2018 and 2023, there were 1,279 RSV-related hospitalisations, with 53.2% of cases being male. Infants under 12 months accounted for the highest proportion of admissions (38.4%). RSV-related hospitalisations peaked during the prospective study period, rising from 123 in 2018 to 357 in 2023. The hospitalisation rate among infants was significantly higher in the prospective study period compared to the retrospective study period (IRR: 2.2; 95% confidence interval [95% CI]: 1.8–2.6; $p < 0.001$). The Indigenous population had a significantly higher hospitalisation rate than the non-Indigenous population over the whole study period (IRR: 3.1; 95% CI: 2.7–3.6; $p < 0.001$). The median length of stay was two days, with 20.6% of those hospitalised requiring ventilation, 2.2% needing intensive care unit (ICU) support, and 0.9% of hospitalisations resulting in death. Mortality was highest among those aged 60 years and above (91.7%). Although infants under 12 months had the lowest RSV testing rates (9.8%), they had the highest test positivity rate (16.4%).

Conclusions

RSV admissions have been under-reported due to limited testing. Increased awareness and widespread testing during prospective surveillance revealed a significant rise in RSV-related admissions. These findings underscore the need for enhanced RSV testing, improved resource allocation, and expanded immunisation efforts to effectively manage the burden of RSV.

Keywords: respiratory syncytial virus; RSV; RSV hospitalisation; paediatric respiratory infections; acute lower respiratory tract infections; epidemiology; RSV testing; respiratory illness; Australia

Background

Respiratory syncytial virus (RSV) is a leading cause of acute lower respiratory tract infections in infants and young children globally, contributing significantly to morbidity and mortality. Annually, RSV accounts for over 33 million episodes of acute lower respiratory tract infections, resulting in more than 3 million hospitalisations and approximately 60,000 to 200,000 deaths in children under five years of age worldwide.¹ While infants and young children bear the greatest burden of RSV, older adults and individuals with chronic illnesses or weakened immune systems are also at high risk of severe disease outcomes.²

Despite this substantial global burden, the absence of a widely available RSV vaccine has made its control a critical public health priority.³ The Therapeutic Goods Administration (TGA) of Australia has approved two RSV vaccines, ABRYSVO and Arexvy, and announced the availability of ABRYSVO vaccine under the National Immunisation Program (NIP) for eligible pregnant women in 2025.⁴ Additionally, monoclonal antibodies, nirsevimab and palivizumab, are available to provide passive immunisation in infants and children under two years.⁴

In Australia, RSV is a major contributor to paediatric hospitalisations, particularly among infants with bronchiolitis and pneumonia. Recent data suggest that 16 per 1,000 infants aged 0–12 months require hospital admissions for RSV in Australia.^{4,5} RSV is also responsible for 39% of viral respiratory-related hospitalisations in children under five.⁶ Among older adults aged 65 and over, RSV-associated hospitalisation rates are estimated to be 0.2 per 1,000 population.⁶ However, predictive models suggest that the actual burden of RSV may be 30–57% higher than the reported hospitalisation rates.⁵ Underreporting of RSV stems from inconsistent testing practices and low awareness among healthcare providers.^{7–9}

RSV testing in Australia is not routinely conducted and varies significantly between facilities, often focusing on hospitalised patients or high-risk individuals.⁶ As a result, many mild to moderate cases go undetected, contributing to an underestimation of RSV's true impact. This underreporting is particularly pronounced in regional areas, where healthcare resources are limited, and diagnostic tools like polymerase chain reaction (PCR) may be less accessible.^{4,10}

Recent evidence also indicates that RSV circulates year-round in regional Queensland, complicating efforts to identify seasonal peaks that guide administration of preventive measures like monoclonal antibodies.¹⁰

While the burden of RSV is well-documented at a national and global level, data on RSV hospitalisation and testing trends in regional areas like Central Queensland remain limited.¹⁰ Most Australian studies focus on metropolitan regions,^{4–6} leaving gaps in understanding the impact of RSV on regional communities. Central Queensland, with its subtropical climate, diverse population, and distinct healthcare challenges, provides a crucial setting for investigating RSV trends.¹¹ This study aimed to assess RSV testing patterns and the associated hospital burden in Central Queensland, providing valuable insights to inform improved diagnostic practices, resource allocation, and preparedness for future RSV outbreaks.

Methods

Study design

This was a hospital-based study of RSV, utilising data from the Hospital Based Corporate Information System (HBCIS) and AUSLAB (i.e. Pathology Queensland).

Population and study setting

The study was conducted within the Central Queensland Hospital and Health Service (CQHHS) catchment area, which covers a population of 238,231 over a large geographical area of 117,800 square kilometres.¹² Approximately 7.2% of the population identify as Aboriginal and Torres Strait Islander people, of whom 12.4% are aged under five years.¹² CQHHS operates 12 public hospitals and provides services for Aboriginal and Torres Strait Islander health, maternity, cancer care, mental health, alcohol and other drugs, oral health, general practitioner (GP) referrals, outreach specialists and more.¹³ Central Queensland has a subtropical climate with hot, wet summers and warm, dry winters with an average annual temperature of 21 °C.¹¹

Eligibility criteria

Individuals presenting to or admitted at any CQHHS hospitals between 1 January 2018 and 31 December 2023 were eligible for inclusion. Participants were required to have either a laboratory-confirmed diagnosis of RSV or a primary/secondary diagnosis of RSV based on the *International Classification of Diseases, Tenth Revision, Australian Modification (ICD-10-AM)* codes J12.1 (RSV pneumonia), J20.5 (RSV bronchitis), J21.0 (RSV bronchiolitis), or B97.4 (RSV as a cause of diseases classified elsewhere).

Data sources and collection

Retrospective phase

(January 2018 – December 2021)

Demographic and clinical data were extracted from the HBCIS and Pathology Queensland databases.

Prospective phase

(January 2022 – December 2023)

During the prospective phase, the Central Queensland Public Health Unit communicated with CQHHS hospitals, multipurpose health centres, residential aged care facilities and pathologies to identify individuals with respiratory symptoms (e.g., cough, sore throat, runny nose, fever) and encourage testing for RSV using multiplex PCR assays. These assays screened for coronavirus disease 2019 (COVID-19); influenza; RSV; parainfluenza; adenovirus; human metapneumovirus and rhinovirus. Data were extracted weekly from the same sources. Population data were extracted from the InfoBank of the Queensland Government.¹⁴

Data management and statistical analysis

Data from 2018–2021 were extracted once, while prospective data (2022–2023) were collected weekly. RSV hospital admission data were extracted from HBCIS using the relevant ICD-10-AM codes (J12.1, J20.5, J21.0, B97.4). RSV PCR test data (test numbers and positive results) for Central Queensland postcodes were extracted from AUSLAB.

Duplicate cases were initially identified and removed using the unique identifier from the database (UR Number). Cases readmitted within 48 hours with identical ICD-10-AM codes were considered part of the same admission episode and removed to avoid redundancy. The final de-duplicated dataset was then de-identified and securely stored on encrypted hard drives within the Queensland Health network and were accessible only to the study team.

Descriptive statistics (e.g., frequencies, proportions) were used to summarise RSV cases and hospitalisations. Hospitalisation rates were calculated by dividing the number of admissions by the age-specific population data and multiplying by 1,000 for each year. Incidence rate ratios (IRR) with 95% confidence interval (95% CI) were computed for hospitalisation rates between the retrospective study period (2018–2021) and the prospective study period (2022–2023). Test positivity rates were determined by dividing the number of positive RSV tests by the total number of tests, expressed as a percentage. Statistical significance was defined as $p < 0.05$.

Results

RSV hospitalisation

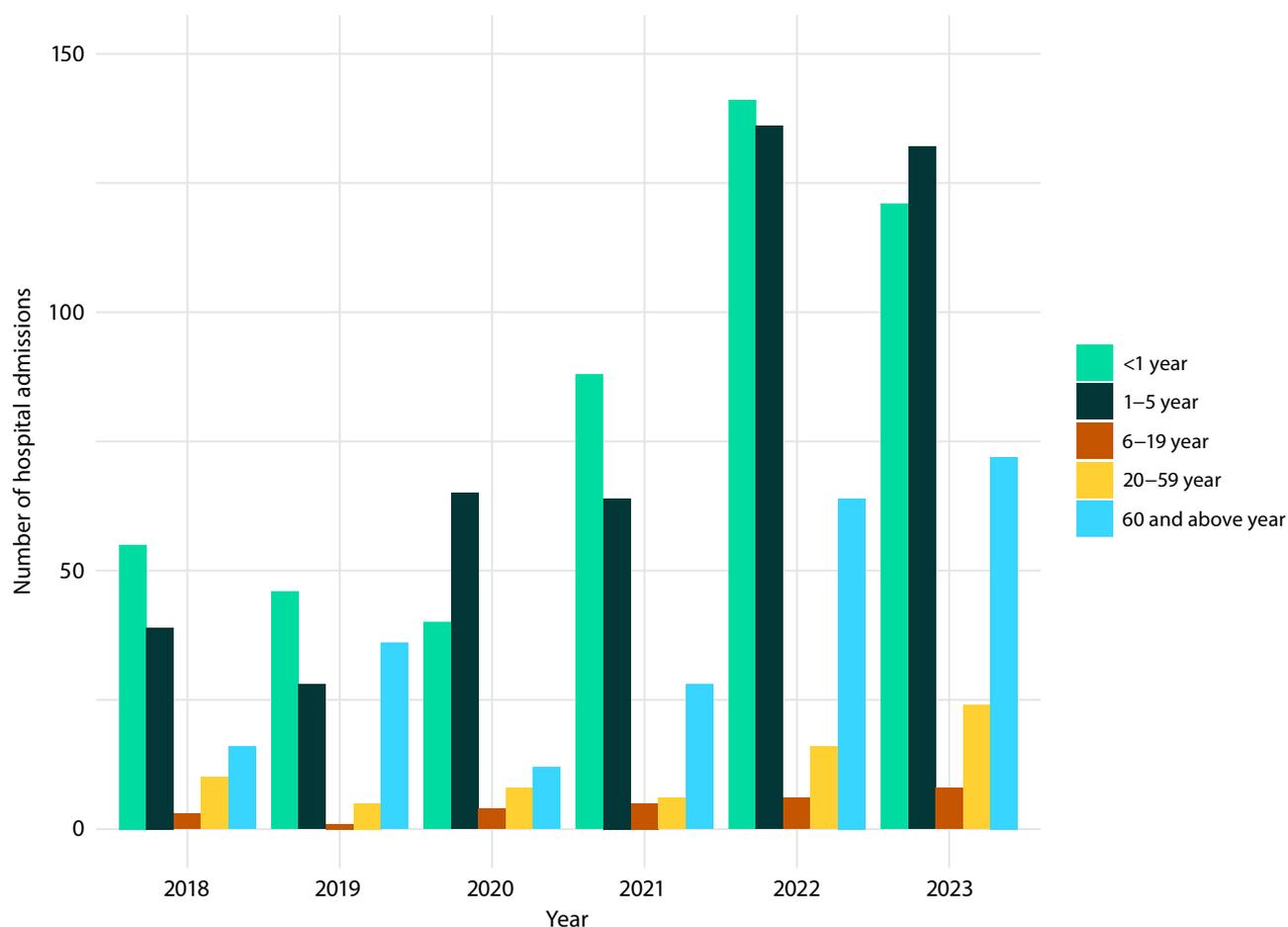
During 2018–2023, a total of 1,279 hospitalisations were recorded with RSV-related ICD codes in Central Queensland. Of these, 52.0% ($n = 665/1,279$ cases) were attributed to RSV as a primary cause. Hospitalisations were most common in infants under 12 months of age ($n = 491/1,279$; 38.4%), followed by children aged 1–5 years ($n = 464/1,279$; 36.3%), and older adults aged 60 years and above ($228/1,279$; 17.8%). Males accounted for a majority of cases ($n = 681/1,279$; 53.2%), while 21.0% of hospitalisations ($n = 268/1,279$) occurred in Indigenous individuals (Table 1).

Table 1: Number and proportion of RSV hospital admissions between 2018 and 2023 in Central Queensland

Category	Characteristics	Hospital admission category					
		Overall (N = 1,279)		RSV as a primary diagnosis (N = 665)		RSV as a secondary diagnosis ^a (N = 614)	
		n	%	n	%	n	%
Age (in years)	< 1	491	38.4	386	58.0	105	17.1
	1–5	464	36.3	208	31.3	256	41.7
	6–19	27	2.1	8	1.2	19	3.1
	20–59	69	5.4	15	2.3	54	8.8
	≥ 60	228	17.8	48	7.2	180	29.3
Sex	Female	598	46.8	311	46.8	287	46.7
	Male	681	53.2	354	53.2	327	53.3
Indigenous status	Aboriginal and/or Torres Strait Islander	268	21.0	146	22.0	122	19.9
	non-Indigenous	1,011	79.0	519	78.0	492	80.1

a Associated diagnosis or complication.

Figure 1: Number of hospital admissions due to RSV in Central Queensland by year and age groups



Age-wise yearly trend of RSV admissions

Analysis of annual trends revealed an increase in RSV admissions from 123 in 2018 to 363 in 2022, with a slight decrease to 357 in 2023. Infants under 12 months consistently accounted for the highest proportion of admissions, while children aged 6–19 years had the lowest proportion. In 2018, infants accounted for 44.7% of admissions ($n = 55/123$), while 13.0% of admissions ($n = 16/123$) were in older adults; by 2023, these proportions shifted to 33.9% ($n = 121/357$) and 20.2% ($n = 72/357$), respectively (Figure 1).

Age-wise hospitalisation rate

Between 2018 and 2023, RSV hospitalisation rates increased significantly across different age groups. Among infants aged under 12 months, the hospitalisation rate rose from 18.6 to 41.2 per 1,000 (IRR: 2.2; 95% CI: 1.8–2.6; $p < 0.001$). Similarly, hospitalisation rates increased from 2.4 to 8.6 per 1,000 in children aged 1–5 years (IRR: 2.9; 95% CI: 2.4–3.4; $p < 0.001$) and from 0.4 to 1.6 per 1,000 in older adults aged 60 years and above (IRR: 2.8; 95% CI: 2.1–3.6; $p < 0.001$). The IRR values and respective 95% CI indicate a significant increase in the hospitalisation rate between the retrospective (2018–2021) and prospective study periods (2022–2023). The hospitalisation rate among the Indigenous population was significantly higher than that among the non-Indigenous population for the whole study period (IRR: 3.1; 95% CI: 2.7–3.6; $p < 0.001$) (Table 2).

Hospitalisation outcomes

Across the whole study period, the median and interquartile range (IQR) of length of hospital stay was two days (interquartile range [IQR]: 1–4 days). A total of 20.6% of patients ($n = 264/1,279$) required ventilation, 2.2% ($n = 28/1,279$) were admitted to the intensive care unit (ICU), and 0.9% of cases ($n = 12/1,279$) resulted in death. Of the twelve deaths, 91.7% ($n = 11/12$) occurred in individuals aged 60 years or older.

The median length of stay was comparable between the retrospective (2018–2021) and prospective (2022–2023) study periods: two days [IQR: 1–4 days] versus two days [IQR: 1–4 days]; $p = 0.054$).

While the proportion of patients admitted to the ICU remained comparable across the two study periods; the proportions of patients who were ventilated (19.6%; $n = 110/559$) versus 21.4%; $n = 154/720$; $p = 0.496$), and of those who died (0.4%; $n = 2/559$ versus 1.2%; $n = 10/720$; $p = 0.078$) increased slightly over time, although without apparent statistical significance.

By comparison with the retrospective period, the length of stay during the prospective period was non-significantly longer for older adults (4 days [IQR: 2–7 days] versus 5 days [IQR: 3–10 days]; $p = 0.136$), while it was significantly shorter in children aged 1–5 years (2 days [IQR: 1–3 days] versus 1 day [IQR: 1–12 days]; $p < 0.001$). Ventilation was most frequently required in individuals aged 20–59 years ($n = 12/40$; 30.0%), while ICU admissions were highest in children aged 6–19 years ($n = 3/14$; 21.4%). Most deaths occurred in patients aged 60 years or older ($n = 9/136$; 6.6%), during the prospective period.

Regarding sex, the median length of stay was similar for males (2 days [IQR: 1–4 days] versus 2 days [IQR: 1–4 days]; $p = 0.099$) and females (2 days [IQR: 1–4 days] versus 2 days [IQR: 1–4 days]; $p = 0.376$) in both surveillance periods. The proportion of females who required ventilation decreased over time (24.1%; $n = 63/261$ versus 21.1%; $n = 71/337$; $p = 0.427$) while this proportion increased for males (15.8%; $n = 47/298$ versus 21.7%; $n = 83/383$; $p = 0.065$). However, during the prospective period, females exhibited a higher proportion than males of both ICU admissions (2.7%; $n = 9/337$ versus 1.6%; $n = 6/377$; $p = 0.439$), and deaths (2.1%; $n = 7/337$ versus 0.8%; $n = 3/383$; $p = 0.387$).

Across both the retrospective and prospective study periods, Indigenous individuals with RSV had a similar median length of stay (2 days [IQR: 1–3 days] versus 2 days [IQR: 1–3 days]; $p = 0.493$) compared to non-Indigenous individuals (2 days [IQR: 1–4 days] versus 2 days [IQR: 1–4 days]; $p = 0.088$). Proportions of Indigenous individuals with RSV increased from the retrospective to the prospective study period for those requiring ventilation (from 16.9% [$n = 21/124$] to 26.4% [$n = 38/144$]; $p = 0.128$), ICU admissions (from 1.6% [$n = 2/124$] to 2.1% [$n = 3/144$]; $p = 1.000$) and deaths (from 0.0% [$n = 0/124$] to 1.4% [$n = 2/144$]; $p = 0.545$).

Table 2: Number, rate and incidence rate ratios of RSV hospital admissions between 2018 and 2023 in Central Queensland

Category	Characteristics	Number of RSV hospitalisations					RSV hospitalisation rate per 1,000 population					2018–2021 vs. 2022–2023				
		2018	2019	2020	2021	2022	2023	2018	2019	2020	2021	2022	2023	IRR ^a	95% CI ^b	p value
Age (in years)	<1	55	46	40	88	141	121	18.6	15.6	13.6	32.1	45.4	41.2	2.2	1.8–2.6	< 0.001
	1–5	39	28	65	64	136	132	2.4	1.8	4.2	4.4	9.4	8.6	2.9	2.4–3.4	< 0.001
	6–19	3	1	4	5	6	8	0.1	0.02	0.1	0.1	0.1	0.2	2.1	1.0–4.5	0.049
	20–59	10	5	8	6	16	24	0.1	0.04	0.1	0.1	0.1	0.2	2.8	1.7–4.4	< 0.001
Indigenous status	≥ 60	16	36	12	28	64	72	0.4	0.9	0.3	0.6	1.3	1.6	2.8	2.1–3.6	< 0.001
	Indigenous	31	18	30	43	67	57	2.0	1.1	1.8	2.4	3.7	3.3	3.1	2.7–3.6 ^c	< 0.001
non-Indigenous	92	98	99	145	252	261	0.5	0.5	0.5	0.7	1.2	1.3				

a IRR: incidence rate ratio.

b 95% CI: 95% confidence interval.

c The differences in hospitalisation rates between Indigenous and non-Indigenous people for the whole period were considered.

RSV testing and positivity trends

During the study period, Pathology Queensland conducted 32,946 RSV tests in Central Queensland, of which 1,872 were positive, resulting in an overall positivity rate of 5.7%. RSV testing increased by a significant 744.4% between 2023 and 2018 (14,219 tests in 2023, when RSV testing was actively advocated, compared to 1,684 tests in 2018). Similarly, RSV-positive cases surged by 243.5% from 186 cases in 2018 to 639 cases in 2023. Despite these increases, the positivity rate declined from 11.0% (n = 186/1,684) in 2018 to 4.5% (n = 639/14,219) in 2023.

Adults aged 20–59 years accounted for the largest proportion of tests (30.2%; n = 9,960/32,946), while infants under 12 months represented the smallest proportion (9.8%; n = 3,218/32,946). However, infants under 12 months had the highest positivity rate (16.4%; n = 528/3,216), whereas individuals aged 60 years and older had the second-lowest positivity rate (2.6%; n = 236/8,950), just above the rate for those aged 20–59 years (1.9%; n = 185/9,960) (Table 3).

Table 3: Number of tests for RSV, number of RSV positive cases and RSV positivity rates by age group between 2018 and 2023 in Central Queensland

Age group (years)	Metric	2018	2019	2020	2021	2022	2023
< 1	Test counts (n)	329	439	242	375	773	1,055
	Test positive cases (n)	67	55	39	56	148	163
	Test positivity rate (%)	20.4	12.5	16.1	14.9	19.1	15.5
1–5	Test counts (n)	441	708	474	757	1,671	2,299
	Test positive cases (n)	72	46	69	85	259	259
	Test positivity rate (%)	16.3	6.5	14.6	11.2	15.5	11.3
6–19	Test counts (n)	196	438	322	446	1,145	1,926
	Test positive cases (n)	11	7	15	17	43	40
	Test positivity rate (%)	5.6	1.6	4.7	3.8	3.8	2.1
20–59	Test counts (n)	402	585	579	1,484	2,518	4,392
	Test positive cases (n)	20	8	8	19	65	65
	Test positivity rate (%)	5	1.4	1.4	1.3	2.6	1.5
≥ 60	Test counts (n)	316	463	346	926	2,352	4,547
	Test positive cases (n)	16	14	6	22	66	112
	Test positivity rate (%)	5.1	3	1.7	2.4	2.8	2.5
Overall	Test counts (n)	1,684	2,633	1,963	3,988	8,459	14,219
	Test positive cases (n)	186	130	137	199	581	639
	Test positivity rate (%)	11.0	4.9	7.0	5.0	6.9	4.5

Discussion

This study aimed to assess RSV testing patterns and the hospital burden of RSV in Central Queensland, revealing a substantial shift in RSV epidemiology over the 2018–2023 period. A key finding was the significantly higher RSV-related hospitalisations, particularly among infants and older adults, during the prospective study period (2022–2023). The number of RSV tests and subsequent number of positive results for all of Central Queensland was also substantially higher during this period; however, the test positive rate was lower in the prospective study period, a finding which may reflect changes in testing practices and/or potential under-reporting of RSV during the earlier retrospective study period (2018–2021). Infants under 12 months of age had the highest hospitalisation and test positive rates, yet they were tested the least compared to other age groups.

This study observed a 190.2% increase in RSV hospital admissions in Central Queensland between 2018 and 2023. This finding is consistent with national trends observed in Australia, where RSV hospitalisations rose following reduced viral circulation during the COVID-19 pandemic.⁴ Similar increases were also reported in the United States of America, with a 166% rise in RSV-related hospitalisation rates among children.¹⁵ This widespread rise may be attributed to increased awareness driven by advocacy for RSV testing and improvements in diagnostic capabilities, including more widespread use of molecular testing for RSV in recent years. Furthermore, reduced population immunity resulting from decreased exposure during lockdowns and social distancing measures implemented during the COVID-19 pandemic likely contributed to the observed rise in hospitalisation rates.¹⁶

Infants under 12 months had the highest RSV hospitalisation rate at 41.2 per 1,000 infants, consistent with a systematic review which reported that the highest risk of RSV-associated hospitalisation was in infants under six months of age.⁴ This age group is particularly vulnerable due to their immature immune systems, which can result in severe RSV infections.¹⁷ The 300% increase in RSV hospitalisation rates among older adults aged 60 years and above highlights the growing burden of RSV in this population, which is corroborated by other studies noting increased morbidity and mortality in older adults due to RSV.^{6,18}

This increase may also reflect improved diagnostic capabilities and more widespread testing for RSV in recent years as well as potential under-reporting in the retrospective period. These findings highlight the urgent need for targeted RSV vaccination in both infants and older adults.

The overall increase in both RSV tests and positive cases during the prospective surveillance phase, along with a decline in the positivity rates, suggests that RSV burden may have been underestimated during the retrospective phase (2018–2021) due to low testing and diagnosis. Enhanced testing campaigns implemented as part of this study during the prospective period revealed a significant higher rate of RSV hospitalisations compared with the retrospective period, likely capturing milder cases that were previously not tested, thereby offering a more accurate reflection of the true burden of RSV. Globally, studies support the finding that active surveillance systems are more effective in accurately capturing the RSV burden as they increase testing rates and yield more precise hospitalisation data.^{19,20} These findings underscore the crucial role of enhanced RSV surveillance and changing RSV testing practices in facilitating earlier detection of RSV and to help prevent hospitalisations through early intervention.

Our analysis of testing patterns revealed an intriguing discrepancy: while infants under 12 months accounted for the lowest number of tests, they had the highest test positivity rate. This pattern may partially reflect the increased testing promotion efforts directed toward older age groups. Although testing may have been appropriately targeted to symptomatic infants, there could be under-testing in this high-risk group, particularly in those with milder symptoms who may have not been tested but could still be at significant risk. Infants may be diagnosed based on clinical presentation rather than laboratory confirmation, leading to fewer tests being conducted.²¹ These findings highlight the need for more targeted testing strategies to ensure that high-risk infants are appropriately tested, even in the absence of severe symptoms.

There are several limitations to this study. The focus on a single region of Australia may limit the generalisability of the findings to other regions with different climates or population demographics. A major limitation is the difference between the two study periods, as testing practices were actively encouraged during the prospective period.

The absence of multiplex PCR testing prior to 2020 in Central Queensland may have influenced the frequency of testing and case detection between the study periods. Additionally, the improved testing systems, along with the notifiable status of RSV in 2021, likely increased public awareness and testing during the latter period, contributing to the observed trends. The recent availability of vaccines and monoclonal antibodies may also have encouraged increased RSV testing and investigations in the latter period. Furthermore, the RSV testing data for this study were limited to a single pathology database, covering 58% of all RSV testing in the region. This limitation excludes data from other centres and may result in underreporting of RSV testing and cases within the region.

Conclusions

This study provides valuable insights into epidemiology of RSV hospitalisations in regional Australia. The increase in the number of RSV-related hospitalisations, particularly among infants and older adults, calls for enhanced prevention strategies, including the roll out of RSV vaccines for all high risk groups.^{23,24} Furthermore, the discrepancy in testing rates among infants suggests a need for further investigation to ensure that all eligible infants, particularly those with respiratory symptoms, are being tested appropriately. Finally, improving awareness of RSV's growing impact on infants and older adults will be essential for enhancing detection and management in these populations.

Ethical considerations

This study involved the use of routinely collected surveillance data, with identifiers removed prior to analysis. Ethical approval was granted by the Central Queensland Hospital and Health Service Human Research Ethics Committee (HREC/2022/QCQ/84099).

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