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Emergency Department presentations related to asthma and allergic diseases in Central Queensland, Australia: a comparative analysis between First Nations Australians and Australians of other descents

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Abstract

Objective: To examine the overall incidence rate and trends in Emergency Department (ED) presentations related to asthma and allergic diseases in regional Australia with a particular focus on First Nations Australians.

Design: A retrospective analysis of data from the Emergency Department Information System.

Setting: This study used data from 12 public hospitals in Central Queensland, Australia, a region encompassing regional, rural, and remote outback areas.

Participants: A total of 813,112 ED presentations between 2018 and 2023.

Outcome measure: Asthma and allergic diseases were identified using the International Classification of Diseases-Tenth Revision-Australian Modification (ICD-10-AM) codes.

Results: There were 13,273 asthma and allergic disease-related ED presentations, with an overall prevalence of 1.6% (95% confidence interval (CI): 1.6, 1.7). There was a significantly higher incidence rate of asthma and allergic disease-related ED presentations among First Nations Australians at 177.5 per 10,000 person-years (95% CI: 169.3, 186.0), compared to 98.9 per 10,000 person-years (95% CI: 97.2, 100.8) among Australians of other descents. The incidence rates, with corresponding 95% CI, of the four most common cases among First Nations Australians and Australians of other descents, respectively, were as follows: asthma (87.8 (82.0, 93.8) and 40.2 (39.0, 41.3)), unspecified allergy (55.3 (50.8, 60.2) and 36.0 (34.9, 37.1)), atopic/allergic contact dermatitis (17.1 (14.6, 19.9) and 10.6 (10.0, 11.2)), and anaphylaxis (7.2 (5.6, 9.1) and 6.2 (5.7, 6.6)).

Conclusion: Our findings highlight a significantly higher rate of asthma and allergic disease-related ED presentations among First Nations Australians compared to Australians of other descents. This underscores the urgent need for targeted healthcare interventions integrating culturally appropriate approaches, alongside additional research to understand causality.

Keywords: Allergic diseases; Asthma; First Nations Australians; Indigenous Australians; Aboriginal and Torres Strait Islander peoples; Australians of other descents; Emergency Department, Trend, Incidence, Central Queensland, Australia

Strengths and limitations of the study

- The study uses the most recent, large data set including First Nations Australians and Australians of other descents and all age groups from a study setting encompassing regional, rural, and remote outback areas.
- The reporting of ED presentations related to asthma and allergic disease relies on the ICD codes entered by physicians at the time of presentation.
- Our study specifically focused on asthma and allergic disease-related ED presentations and did not encompass all instances of acute asthma and allergic diseases in the general population which may visit health facilities in routes other than ED.

Introduction

Chronic diseases including asthma and allergy, are a leading cause of premature death and morbidity globally[1 2] and constitute a growing public health concern.[3-5] It is estimated that by 2050, 50% of the world's population will be affected by allergies.[1 6] In Australia, often labelled as the 'allergy capital of the world',[7] allergy is currently estimated to affect 4.1 million people and is anticipated to undergo a 70% surge, with affected individuals projected to reach 7.7 million (26.1%) by 2050.[3]

Allergic diseases exert considerable economic and social impact and negatively impact individuals' and families' day-to-day living as well as quality of life.[8 9] The overall economic cost of food allergy alone in the United States was estimated to be USD 24.8 billion annually or USD 4184 per child.[10] The total Medicare cost for out-of-hospital services related to food allergy in children aged 1 to 4 years in Melbourne, Australia alone was estimated at AUD 26.1 million annually.[11]

There are clear racial, ethnic, and socioeconomic disparities in allergic diseases worldwide.[12-14] Studies conducted on the burden of allergic disease in racially and ethnically structurally oppressed communities in Canada and the United States (US) showed an increased burden of allergic and atopic diseases among the Indigenous peoples of Canada.[15 16] Specifically, studies[15 16] reported a significantly higher prevalence of current eczema (25% among Indigenous children compared to 14.3% among non-Indigenous children), current allergic rhinitis (12.5% among Indigenous children compared to 0.0% among non-Indigenous children), environmental allergy (4.2% among Indigenous and 0.0% among non-Indigenous), and past asthma (16.7% among Indigenous children compared to 14.2% among non-Indigenous children). However, little is known about the prevalence of allergies and anaphylaxis in First Nations Australians.[17] In our study, the phrase 'First Nations Australians' respectfully refers to the Aboriginal and Torres Strait Islander peoples in Australia.[18]

In general, the burden of disease is 2.3 times higher among First Nations Australians,[19] and health outcomes are poorer when compared to Australians of other descents.[20] Asthma was the third most commonly reported long-term condition (16%) affecting First Nations Australians,[21 22] and First

Nations Australian children had a 2.3 times higher prevalence of asthma than Australian children of other descents.[23] However, there has been little research into other types of allergic disease in First Nations Australians.

Existing evidence from other countries suggests that disparities in the prevalence of allergic diseases exist between rural and urban areas. For example, a study conducted in South Africa reported a higher prevalence of self-reported allergies and a higher prevalence of objectively measured food allergy in urban areas compared to rural areas.[24 25] This underscores the importance of conducting region-specific studies to inform targeted interventions and healthcare strategies. There has been little research into allergic disease in regional and rural areas of Australia. The lack of comprehensive data in these areas hinders our understanding of the unique factors influencing allergies in regional settings, including distinct environmental exposures and lifestyle variations. Although some evidence[26] suggests that certain allergies, including food allergies and eczema, may be less common in Northern Australia based on self-report, region-specific further studies are required to inform targeted interventions and healthcare strategies.

The current study endeavours to fill some of the existing evidence gaps by examining incidence rate and trends of ED presentations related to asthma and allergic diseases, both collectively and individually, among both First Nations Australians and Australians of other descents in Central Queensland, which encompasses both regional and rural and remote areas, from 2018 to 2023.

Methods

We conducted a retrospective analysis of data from the Emergency Department Information System (EDIS) of Public Hospitals in Central Queensland (CQ), a regional district of Queensland, Australia, located in the central east region (the study area map can be found in online Supplemental Figure 1 1).[27] The map was developed using the digital boundary files from the Australian Bureau of Statistics.[28] CQ encompasses rural and remote outback towns.[29] This analysis focused on the service catchment area of Central Queensland Hospital and Health Service (CQHHS) and included all patients presenting

to the emergency department. CQHHS operates 12 public hospitals across various regions. These include 1) Rockhampton, Mount Morgan, and Capricorn Coast, situated within Inner Regional Australia, 2) Gladstone, Biloela, Emerald, Baralaba, Moura, Theodore, and Blackwater, which fall under Outer Regional Australia, and 3) Woorabinda and Springsure, located in Remote Australia.[30 31] CQHHS also provides Aboriginal and Torres Strait Islander Health, Maternity services, CQ Cancer Care Services, Mental Health, Alcohol and Other Drugs Services, Oral Health and General Practitioner referrals.[30] In this analysis, we used data only from ED presentations. Data from the 2021 national census show that the CQ region was populated by 228,246 people.[32] There were 59,070 families in CQ; the median age was 38 years and 64% of the population was aged between 15–64 years.[32] Over seven per cent (7.2%) of the total population in CQ identify as First Nations Australians.[32]

We identified ED presentations related to asthma and allergic disease by using the International Classification of Diseases-Tenth Revision-Australian Modification (ICD-10-AM) codes, as detailed in Supplemental Table 1. Given that not all asthma cases are necessarily allergic,[33 34] and considering that our dataset encompasses the ICD code J45.9, indicative of unspecified asthma, we presented asthma both independently and collectively with allergic diseases. This approach aims to clarify both the overall burden of asthma and allergic diseases collectively, as well as specific instances.

We described the overall asthma and allergic disease-related ED presentations using covariates available in the administrative data. These were self-reported indigenous status (Aboriginal and/or Torres Strait Islanders, which are categorised into First Nations Australians, and not-Indigenous and not stated, which are categorised into Australians of other descents[35]), sex (female and male and intersex (intersex were combined with male because there were only 106 (0.01%) individuals who identified themselves as intersex), age group in years (≤ 4, 5-14, 15-29, 30-44, 45-59, 60+), hospital (Baralaba, Biloela, Blackwater, Emerald, Gladstone, Mount Morgan, Moura, Rockhampton, Springsure, Theodore, Woorabinda, and Yeppoon) as indirect indicator of place of residence.

Data management and statistical analysis

Data for the period January 2018 to November 2023 were retrieved in a one-time extraction from the data sources, deidentified, replaced with unique codes, and securely stored. We described participants' characteristics using frequency with per cent. P values were calculated using Pearson's χ^2 test. The incidence rates, with 95% confidence intervals (CIs), assuming a Poisson distribution, were calculated as the number of new asthma and allergic disease-related ED presentations per year divided by the total population of Central Queensland at risk during the same period. The total population of Central Queensland at risk per year was estimated as the total population of Central Queensland as reported by the Australian Bureau of Statistics.[36] The comparison of incidence and trends of asthma and allergic disease-related ED presentations over time was assessed using Poisson regression, presented as incidence rate ratios (IRRs) with corresponding 95% CIs. We used the goodness-of-fit chi-squared test to assess whether the Poisson model adequately fit our data. All P-values for these tests were not statistically significant (data not presented), suggesting that the Poisson model reasonably fits the observed data. Incidence rates specific to overall, indigenous status, and other available covariates, as described above, were presented.

Patient and public involvement

Patients and/or the general public were not involved in the design, or conduct, or drafting of this secondary analysis.

Results

There were a total of 813,112 ED presentations between January 2018 and November 2023, ranging from 1,248 (0.1%) in Baralaba to 303,138 (37.3%) in Rockhampton (Supplemental Table 2).

Background characteristics of patients presenting with asthma and allergic diseases

Table 1 presents the background characteristics of patients presenting to the ED due to asthma and allergic diseases. Statistically significant differences were observed in overall asthma and allergic disease-related ED presentations, with a higher proportion among females (1.8%), children aged

between 5-14 (2.8%), children aged under five (2.5%), and across various hospital catchment areas (Table 1).

Incidence rates of asthma and allergic disease-related ED presentations

Overall, the rate of asthma and allergic disease-related ED presentations was 96.9 per 10,000 person-years (95% CI: 95.3, 98.6). There was a higher rate of asthma and allergic disease-related ED presentations among the First Nations Australians, which was 177.5 per 10,000 person-years (95% CI: 169.3, 186.0), compared to the incidence rate among Australians of other descents, which was 98.9 per 10,000 person-years (95% CI: 97.2, 100.8).

Table 2 illustrates the incidence rate of the specific case between 2018 and 2023. The four most common cases presenting to emergency departments were asthma (40.5/10,000 person-years, 95% CI: 39.4, 41.5), unspecified allergy (34.6/10,000 person-years, 95% CI: 33.6, 35.6), atopic/allergic contact dermatitis (10.3/10,000 person-years, 95% CI: 9.7, 10.8) and anaphylaxis and anaphylactic shock (5.8/10,000 person-years, 95% CI: 5.4, 6.2). There was a higher incidence rate of asthma, unspecified allergy, atopic/allergic contact dermatitis and allergic urticaria among First Nations Australians compared to Australians of other descents. No food allergy presentations were reported in our data (Table 2).

Time trend of asthma and allergic disease-related ED presentations

Figure 1 presents the time trend in the rates of asthma and allergic disease-related ED presentations in Central Queensland. Except for the notable increase observed between 2018 and 2019, collective asthma and allergic disease-related ED presentations among First Nations Australians remained relatively stable. These rates ranged from 132.3 per 10,000 person-year (95% CI: 115.3, 151.1) in 2018 to 157.2 per 10,000 person-year in 2023 (95% CI: 138.6, 177.5; P=0.462). Similarly, rates of asthma and allergic disease-related presentations among Australians of other descents were nearly stable, varying from 94.0 per 10000 person-year (95% CI: 89.8, 98.4) in 2018 and 88.6 per 10000 person-year (95% CI: 84.5, 92.9, p =0.846) in 2023.

Figure 2 shows the time trend of ED presentation rates related to asthma and allergic disease separately. There was a significant increase in the rate of allergic diseases among First Nations Australians over time ($P\ value = 0.026$). Except for the peak observed in 2019 among First Nations Australians, asthma-related ED presentations remained relatively stable over time in both First Nations Australians and Australians of other descents.

Table 3 presents the total incidence of asthma and allergic disease-related ED presentations over the study period by gender and age group. The incidence rate of asthma and allergic disease-related ED presentations remained stable across indigenous status, gender, and age groups, with one exception. Among children aged 4 years or younger, there was a significant decline in the overall incidence of asthma and allergic disease-related ED presentations (IRR = 0.94, 95% CI: 0.91, 0.97, P<0.001) (Table 3).

Discussion

To the best of our knowledge, this is the first study to examine asthma and allergic disease-related ED presentations among both First Nations Australians and Australians of other descents in an understudied region of Australia, which encompasses both rural and remote outback towns. There was a significant increase in the rate of allergic diseases among First Nations Australians between 2018 and 2023. First Nations Australians in CQ experienced a significant rise in allergic diseases, with higher rates of ED presentations compared to Australians of other descents. Asthma, unspecified allergies, atopic/allergic contact dermatitis, and anaphylaxis/anaphylactic shock were the most common conditions observed in the ED presentations, with higher rates among First Nations Australians compared to Australians of other descents.

The higher rate of ED presentations related to allergic disease among First Nations Australians was surprising given that allergic and atopic diseases have not been traditionally recognised as an important concern among First Nations Australians.[37] Nevertheless, there is currently a growing recognition of this issue. Our findings highlight a substantial and potentially increasing burden of

allergic disease among First Nations Australians living in a region encompassing regional, rural, and remote outback areas. This finding is in agreement with the findings of a study conducted in Canada and the US that showed an increased burden of allergic and atopic diseases among the Indigenous peoples of Canada.[15] Other previous studies conducted in the US and Australia, while lacking specific data on First Nations populations, also documented the existence of racial, ethnic, and socioeconomic disparities in food allergies.[12-14] Further studies are warranted to understand the underlying causes of these observed disparities.

There was a notable peak in recorded asthma-related ED presentations among First Nations Australians in 2019. This could be partially attributed to the bushfires that swept across Australia in 2019–20, also known as Black Summer, as asthma was one of the primary reasons for the ED presentations. Evidence shows that the national increase in emergency presentation and hospitalisation rates for asthma and chronic obstructive pulmonary disease (COPD) coincided with increased bushfire activity during the 2019–20 bushfire season.[38] Bushfire smoke exposure was significantly associated with an increased risk of respiratory morbidity and other health impacts.[39 40] The notable spike in recorded asthma-related ED presentations could also be ascribed to the notably vigorous flu season in 2019,[41] which is recognised as one of the triggers for an asthma attack.[42]

The primary reason for ED presentations was asthma, with a significantly higher incidence observed among First Nations Australians compared to Australians of other descents. Within our dataset, asthma cases could encompass both allergic and non-allergic variants. Literature documented that First Nations Australians were 1.6 times more likely to report having asthma in 2018-19 compared with Australians of other descents.[43] Another study that used birth, hospital and emergency data for all First Nations Australian children born between 2003 and 2012 in Western Australia reported that 2.7% of children had been hospitalised for asthma at least once between the ages of 1 and 4 years.[44] The higher incidence in asthma related ED presentation could be multifactorial including first time/ unrecognised asthma, unmet medical need, unsuccessful/inadequate home management, medication

non-adherence, exacerbation triggered by environmental factors, including bushfire, environmental pollution, and risky health behaviours such as smoking. Literature has documented that nearly half (47%) of the respiratory disease burden among First Nations Australians in 2018 was linked to smoking.[45] The lack of access to culturally appropriate asthma education and healthcare services could also contribute to the higher incidence of asthma related ED presentations among First Nations Australians.[46]

Atopic/allergic contact dermatitis ranked as the third most common cause for ED visits, with a higher rate noted among First Nations Australians compared to Australians of other descents. A 5-year retrospective audit of all outpatient encounters with a visiting dermatology specialist in the Kimberley region of Western Australia reported that eczema/dermatitis was the primary condition seen in First Nations Australians (19%) and third most common in Australians of other descents (17%).[47] Another study conducted in Melbourne between 2009 and 2011 reported that 3.9% of ED presentations were due to skin complaints, of which eczema/dermatitis was the fourth most common dermatological condition although data on the indigenous status of the study population[48] was not reported. It is documented that atopic dermatitis is associated with a higher risk of other atopic disorders, including asthma, hay fever, food allergy, and eosinophilic esophagitis.[49] It is also a known risk factor for streptococcal skin infection[49-52] and subsequent systemic and life-threatening complications including sepsis, endocarditis, and bone and joint infections if left untreated.[49 53-55] For instance, a study at the Wuchopperen Clinic in Cairns, Far North Queensland, found that 73.7% of children and youths treated for skin infections tested positive for group A streptococcus.[56]

We found that anaphylaxis/anaphylactic shock was the fourth most common cause of allergy related ED presentations. Previous studies conducted in Australia[57 58] documented an increase in the rate of anaphylaxis over time although they lack data based on indigenous status. A study conducted in Victoria reported that the causes of anaphylaxis-related ED presentations were foods (62%); drugs (12%), insect venoms (8%), and other causes (4%).[59] The current study lacked data to specify the

causes of anaphylaxis/ anaphylactic shock. Interestingly, there were no food allergy presentations recorded in our data. However, it is possible that a substantial portion of the unspecified allergies, which was the second most frequent cause of ED presentations, may be linked to food allergies. Further studies are required to fill this evidence gap in our study area.

There was a twofold higher rate of allergic urticaria, which ranked as the fifth leading cause of ED visits, among First Nations Australians compared to their counterparts. A study conducted in Italy reported that acute urticaria in 1 year accounted for 1.01% of total ED visits and 1.2 admissions per day [60] and drugs, insect bites, foods and contact urticaria were the most common triggers identified. With a presumption that allergic urticaria that results in ED presentation in our study is acute urticaria [61], literature documented its risk factors including high population density,[62] personal[63] and parental history of allergic diseases,[64 65] poverty and lower socio-economic status.[62 66] Further studies are required to understand risk factors associated with allergic urticaria, particularly among First Nations Australians.

Strengths of the study include the use of the most recent, large data set including both First Nations Australians and Australians of other descents and all age groups from a study setting encompassing regional, rural, and remote outback areas. As a limitation, the reporting of ED presentations related to asthma and allergic disease relies on the ICD codes entered by physicians at the time of presentation. Our study specifically focused on asthma and allergic disease-related ED presentations and did not encompass all instances of acute asthma and allergic diseases in the general population which may visit health facilities in routes other than ED. Caution should be taken when generalising our results to the broader population, as they may not fully reflect the overall incidence of asthma and allergic diseases in the community but asthma and acute allergic disease resulting in ED visits only. Our analyses were limited to factors available in the administrative data, not comprehensively incorporating other important factors, including socioeconomic status, which encompasses education, financial resources, social standing, access to transportation, mobile phones, the internet,

housing conditions, and geographic location,[67] comorbidities, time of first allergy diagnosis, family history of allergies, obesity/overweight, smoking status, and environmental factors among others. For instance, literature has documented that social disadvantage impacts many aspects of allergic disease, including healthcare access, prevalence, and outcomes.[12 68] Therefore, further research is needed to explore the overall incidence of asthma and allergic diseases, considering a comprehensive set of potential confounders, to provide a more thorough understanding of both overall allergy incidence and its associated factors. Also, it is important to note that our study relied on the accurate reporting of individuals' indigenous status in medical records.

Conclusion

Our findings highlight a significantly higher rate of asthma and allergic disease-related ED presentations among First Nations Australians compared to Australians of other descents in Central Queensland. This underscores the urgent need for further research to understand the causality and targeted healthcare interventions integrating a culturally sensitive approach.

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Contributors

All authors (DMS, MHA, DM, RW, PDS, CFM, RLP, GK, JJK) contributed to the design of the study and the interpretation of data. DMS performed the data analysis and drafted the manuscript. All authors (DMS, MHA, DM, RW, PDS, CFM, RLP, GK, JJK) read, revised, and approved the final manuscript.

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Conflict of interest

All other authors declare no conflict of interest.

Patient consent for publication

Not required.

Ethics approval

We obtained ethics approval from the Human Research Ethics Committee (HREC) of the Central Queensland Hospital and Health Service (CQHHS) (Reference Id: 101806). Owing to the retrospective design of this study and its reliance on routinely collected hospital administrative data for medical services, seeking individual consent was deemed unnecessary.

Data availability statement

Data are not publicly available and may be obtained from a third party. Deidentified patient data can be requested from the Central Queensland Hospital and Health Service (CQHHS).

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Table 1. Background characteristics of patients presenting with asthma and allergic diseases compared to individuals presenting to ED for other reasons (N=813112)

Variable		Asthma and allergic disease-related ED presentations		P value
		No	Yes	
Indigenous status (n=812995)				
	First Nations Australians	107099 (98.4)	1755 (1.6)	0.569
	Australians of other descent /Not Stated	692623 (98.4)	11518 (1.6)	
Sex				
	Female	397513 (98.2)	7395 (1.8)	< 0.001
	Male and intersex	402325 (98.6)	5879 (1.4)	
Age group (Year, n=813111)				
	≤4	78484 (97.5)	2018 (2.5)	< 0.001
	5-14	87248 (97.2)	2540 (2.8)	
	15-29	180778 (98.4)	2905 (1.6)	
	30-44	148,015 (98.5)	2285 (1.5)	
	45-59	129214 (98.4)	2051 (1.6)	
	60+	176,098 (99.2)	1475 (0.8)	
Hospital				
	Baralaba	1234(98.9)	14(1.1)	<0.001
	Biloela	41009(98.0)	853(2.0)	
	Blackwater	25048 (98.1)	474 (1.9)	
	Emerald	83599(98.6)	1216 (1.4)	
	Gladstone	203136(98.2)	3618(1.8)	
	Mount Morgan	15972(98.1)	301(1.9)	
	Moura	12457(98.1)	241(1.9)	
	Rockhampton	298827(98.6)	4311(1.4)	
	Springsure	7983(98.2)	144(1.8)	
	Theodore	1414(98.7)	19(1.3)	
	Woorabinda	12894(98.2)	239(1.8)	
	Yeppoon	96265(98.1)	1844(1.9)	

ED= Emergency Department

Table 2. Incidence rate of asthma and allergic diseases from 2018 to 2023.

Asthma and allergic diseases	Asthma and specific type of allergy (per 10000 person-year with 95% CI)		
	First Nations Australians	Australians of other descent	Overall
Asthma*	87.8 (82.0, 93.8)	40.2 (39.0, 41.3)	40.5 (39.4, 41.5)
Unspecified allergy*	55.3 (50.8, 60.2)	36.0 (34.9, 37.1)	34.6 (33.6, 35.6)
Atopic/allergic contact dermatitis*	17.1 (14.6, 19.9)	10.6 (10.0, 11.2)	10.3 (9.7, 10.8)
Anaphylaxis and anaphylactic shock	7.2 (5.6, 9.1)	6.2 (5.7, 6.6)	5.8 (5.4, 6.2)
Allergic urticaria*	4.0 (2.9, 5.5)	2.3 (2.1, 2.6)	2.3 (2.0, 2.5)
Allergic conjunctivitis*	3.6 (2.5, 5.0)	2.4 (2.1, 2.7)	2.3 (2.1, 2.6)
Allergic rhinitis*	1.9 (1.2, 3.0)	0.7 (0.6, 0.9)	0.8 (0.6, 0.9)
Allergic purpura	0.5 (0.2, 1.2)	0.5 (0.4, 0.7)	0.5 (0.4,0.6)
Overall allergic diseases*, **	89.7 (83.9, 95.8)	58.8 (57.4, 60.2)	56.4 (55.2, 57.7)

*P value < 0.05 when comparing the incidence rate per person-year between First Nations Australians and Australians of other descent, **Overall allergic diseases encompass all specific allergic diseases, including unspecified allergy, atopic/allergic contact dermatitis, anaphylaxis, and anaphylactic shock, allergic urticaria, allergic conjunctivitis, allergic rhinitis, and allergic purpura but not asthma

526 **Table 3.** Incidence of asthma and allergic disease-related ED presentations (per 10,000 person-years) from 2018 to 2023

Year	Asthma and allergic disease-related ED presentations							
	Sex		Age (Year)					
	Female	Male and intersex	0-4	5-14	15-29	30-44	45-59	**60+**
2018	101.2	78.2	281.6	111.9	99.0	75.0	64.5	47.9
2019	116.7	89.4	262.6	147.8	119.0	77.5	82.5	55.4
2020	105.4	80.7	208.9	105.0	108.9	98.3	80.5	44.7
2021	123.6	97.2	240.7	134.2	138.5	100.1	95.3	57.0
2022	111.9	86.9	222.3	134.2	135.6	84.2	74.5	46.3
2023	96.6	76.9	208.2	133.0	97.4	76.6	60.9	44.5
IRR (95% CI)	0.99 (0.95, 1.04)	1.001 (0.951, 1.053)	0.94 (0.91, 0.97)	1.02 (0.97, 1.06)	1.02 (0.97, 1.06)	1.01 (0.96, 1.06)	0.98 (0.93, 1.04)	0.98 (0.91, 1.05)
P value	0.824	0.974	<0.001	0.320	0.432	0.700	0.710	0.587

527 ED= Emergency Department, IRR= Incidence rate ratio, CI= Confidence interval

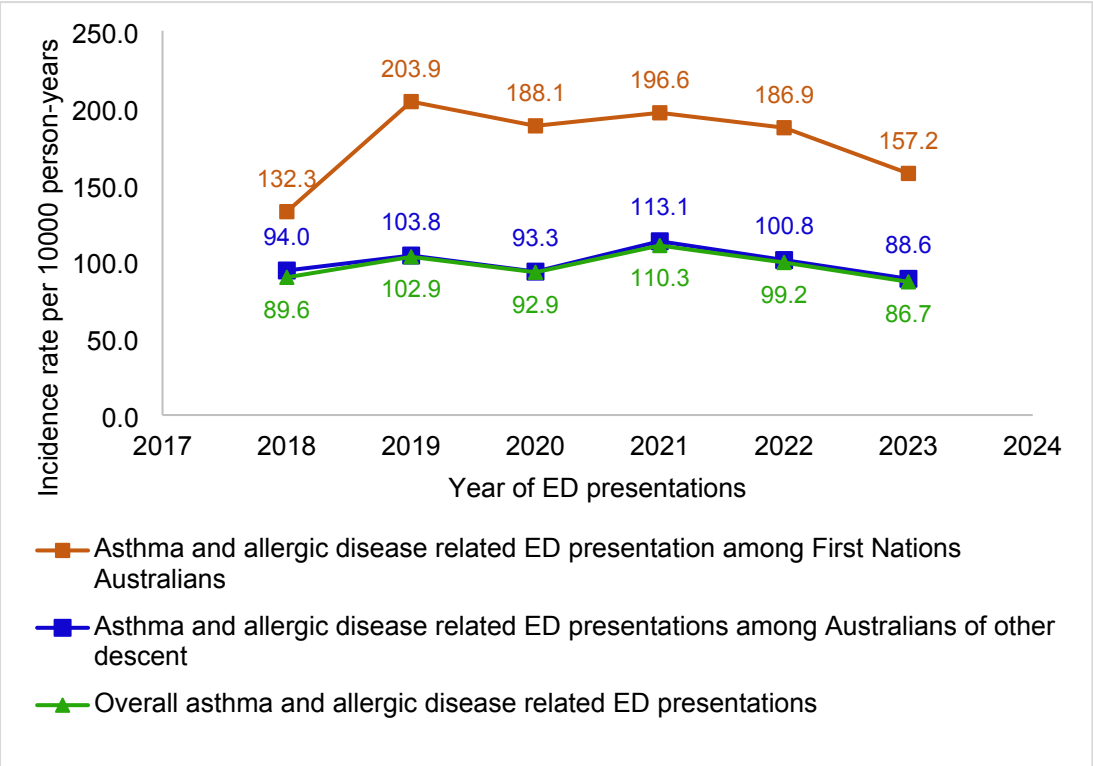


Figure 1. Incidence of both asthma and allergic disease-related Emergency Department presentations in Central Queensland between 2018 and 2023
ED= Emergency Department

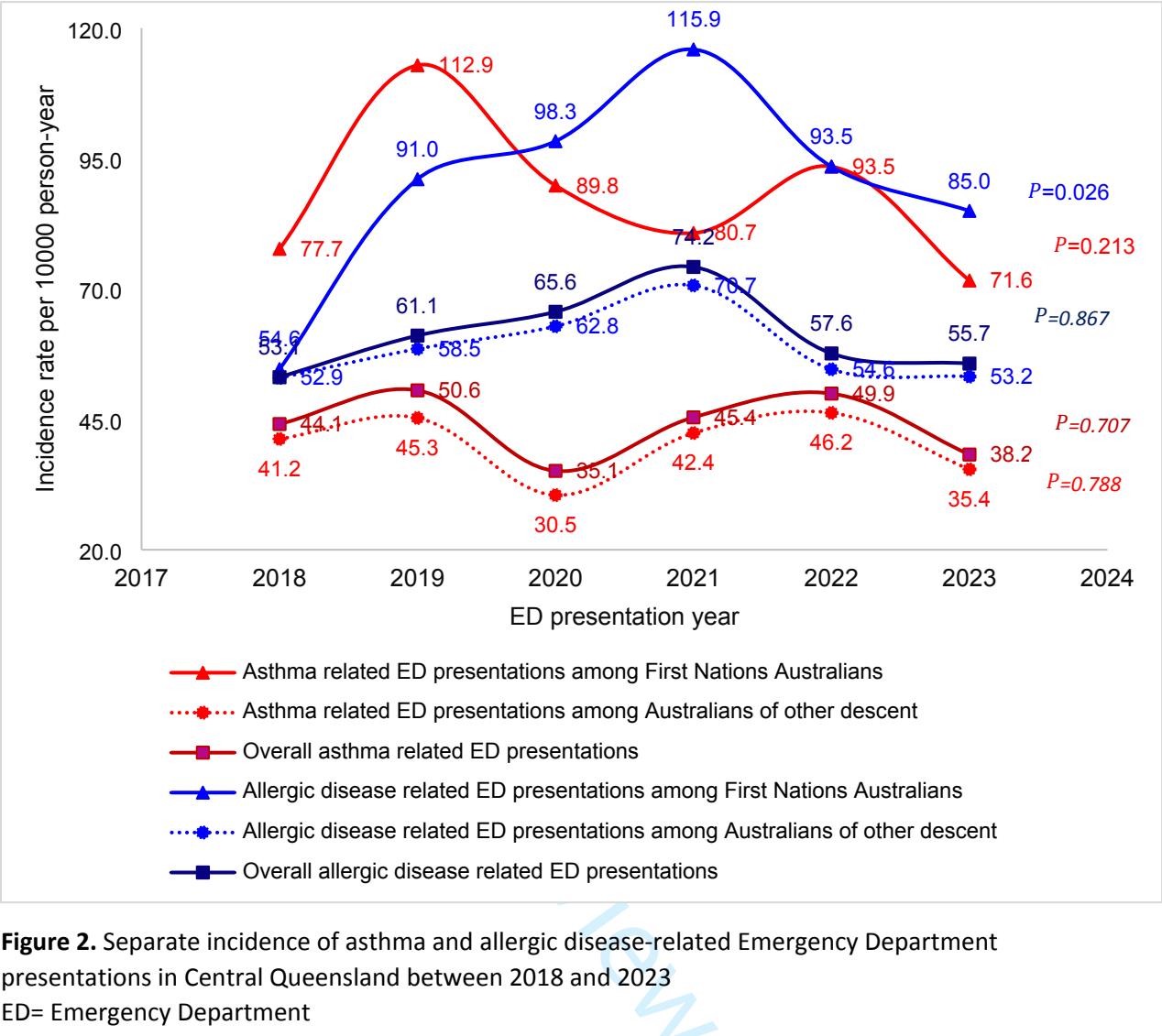


Figure 2. Separate incidence of asthma and allergic disease-related Emergency Department presentations in Central Queensland between 2018 and 2023
ED= Emergency Department

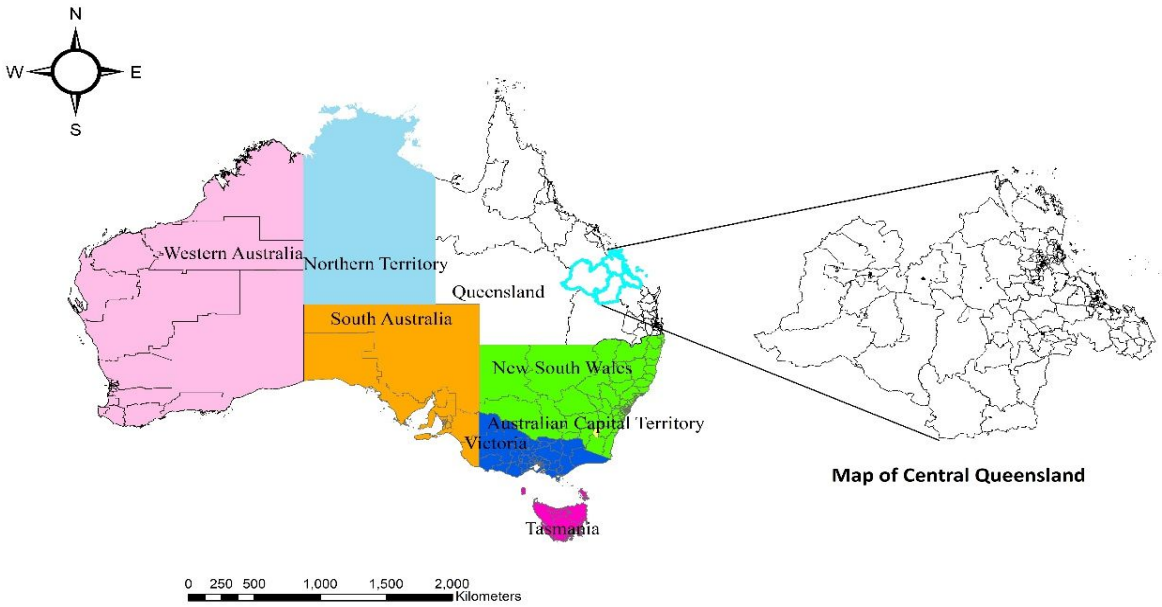
Supplemental Table 1. ICD-10-AM codes related to allergic conditions.

Condition	ICD-10-AM Code
Allergy, unspecified	T78.4, Z91.0
Allergic atopic dermatitis	L20, L20.8, L20.9
Allergic contact dermatitis	L23, L23.0-L23.9
Allergic conjunctivitis	H10.1, H10.2, H10.3, H10.4,
Allergic gastroenteritis	K52.2
Allergic purpura	D69.0
Allergic rhinitis	J30, J30.1, J30.2, J30.3, J30.4, J30.5
Allergic urticaria	L50.0, L50.8
Anaphylaxis	T78.0, T78.1, T78.2, T80.5, T88.6
Asthma	J45.0, J45.8, J45.9, J46
Food allergy	Y37.0-Y37.9, Y37.2, Y37.20, Y37.21, Y37.22, Y37.23, Y37.29, Y37.3, Y37.30, Y37.31, Y37.32, Y37.39, Y37.4, Y37.5

Supplemental Table 2. Emergency Department presentations at Public Hospitals in Central Queensland, 1 January 2018 to 30 November 2023 (N=813, 122)

Hospital	Year Frequency (%)						
	2018	2019	2020	2021	2022	2023	Total
Baralaba	X	X	X	237 (19.0)	547 (43.8)	464 (37.2)	1248 (100.0)
Biloela	6549 (15.6)	6394 (15.3)	7312 (17.5)	7268 (17.4)	7294 (17.4)	7045 (16.8)	41862 (100.0)
Blackwater	1207 (4.7)	5184 (20.3)	4453 (17.5)	4651 (18.2)	4752 (18.6)	5275 (20.7)	25522 (100.0)
Emerald	12320 (14.5)	13129 (15.5)	13110 (15.5)	16036 (18.9)	15639 (18.4)	1458 (17.2)	84815 (100.0)
Gladstone	31065 (15.0)	34340 (16.6)	36627 (17.7)	36349 (17.6)	36209 (17.5)	32164 (15.6)	206754 (100.0)
Mount Morgan	805 (4.9)	2925 (18.0)	2820 (17.3)	3280 (20.2)	3448 (21.2)	2995 (18.4)	16273 (100.0)
Moura	481 (3.8)	2158 (17.0)	2410 (19.0)	3118 (24.5)	2603 (20.5)	1928 (15.2)	12698 (100.0)
Rockhampton	47270 (15.5)	50522 (16.7)	49869 (16.5)	55777 (18.4)	52708 (17.4)	46992 (15.5)	303138 (100.0)
Springsure	337 (4.1)	1565 (19.3)	1697 (20.9)	1644 (20.2)	1535 (18.9)	1349 (16.6)	8127 (100.0)
Theodore	X	X	X	290 (20.2)	586 (40.9)	557 (38.9)	1433 (100.0)
Woorabinda	380 (2.9)	2107 (16.0)	2497 (19.0)	2476 (18.9)	2903 (22.1)	2770 (21.1)	13133 (100.0)
Yeppoon	14540 (14.8)	15017 (15.3)	15500 (15.8)	19797 (20.2)	17577 (17.9)	15678 (16.0)	98109 (100.0)
Total	114954 (14.1)	133341 (16.4)	136295 (16.8)	150923 (18.6)	145801 (17.9)	131798 (16.2)	813112 (100.0)

X= ED services were not available.



Supplemental Figure 1. Locator map of the study area.

Source: The map was developed using the digital boundary files from the Australian Bureau of Statistics.

BMJ Open

Emergency Department presentations related to asthma and allergic diseases in Central Queensland, Australia: a comparative analysis between First Nations Australians and Australians of other descents

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Emergency Department presentations related to asthma and allergic diseases in Central Queensland, Australia: a comparative analysis between First Nations Australians and Australians of other descents

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Abstract

Objective: To examine the overall incidence rate and trends in Emergency Department (ED) presentations related to asthma and allergic diseases in regional Australia with a particular focus on First Nations Australians.

Design: A retrospective analysis of data from the Emergency Department Information System.

Setting: This study used data from 12 public hospitals in Central Queensland, Australia, a region encompassing regional, rural, and remote outback areas.

Participants: A total of 813,112 ED presentations between 2018 and 2023.

Outcome measure: Asthma and allergic diseases were identified using the International Classification of Diseases-Tenth Revision-Australian Modification (ICD-10-AM) codes.

Results: There were 13,273 asthma and allergic disease-related ED presentations, with an overall prevalence of 1.6% (95% confidence interval (CI): 1.6, 1.7). There was a significantly higher incidence rate of asthma and allergic disease-related ED presentations among First Nations Australians at 177.5 per 10,000 person-years (95% CI: 169.3, 186.0), compared to 98.9 per 10,000 person-years (95% CI: 97.2, 100.8) among Australians of other descents. The incidence rates, with corresponding 95% CI, of the four most common cases among First Nations Australians and Australians of other descents, respectively, were as follows: asthma (87.8 (82.0, 93.8) and 40.2 (39.0, 41.3)), unspecified allergy (55.3 (50.8, 60.2) and 36.0 (34.9, 37.1)), atopic/allergic contact dermatitis (17.1 (14.6, 19.9) and 10.6 (10.0, 11.2)), and anaphylaxis (7.2 (5.6, 9.1) and 6.2 (5.7, 6.6)).

Conclusion: Our findings highlight a significantly higher rate of asthma and allergic disease-related ED presentations among First Nations Australians compared to Australians of other descents. This underscores the urgent need for targeted healthcare interventions integrating culturally appropriate approaches, alongside additional research to understand causality.

Keywords: Allergic diseases; Asthma; First Nations Australians; Indigenous Australians; Aboriginal and Torres Strait Islander peoples; Australians of other descents; Emergency Department, Trend, Incidence, Central Queensland, Australia

Strengths and limitations of the study

- The study uses the most recent, large data set including First Nations Australians and Australians of other descents and all age groups from a study setting encompassing regional, rural, and remote outback areas.
- The reporting of ED presentations related to asthma and allergic disease relies on the ICD codes entered by physicians at the time of presentation.
- Our study specifically focused on asthma and allergic disease-related ED presentations and did not encompass all instances of acute asthma and allergic diseases in the general population which may visit health facilities in routes other than ED.

Introduction

Chronic diseases including asthma and allergy, are a leading cause of premature death and morbidity globally[1 2] and constitute a growing public health concern.[3-5] It is estimated that by 2050, 50% of the world's population will be affected by allergies.[1 6] In Australia, often labelled as the 'allergy capital of the world',[7] allergy is currently estimated to affect 4.1 million people and is anticipated to undergo a 70% surge, with affected individuals projected to reach 7.7 million (26.1%) by 2050.[3]

Allergic diseases exert considerable economic and social impact and negatively impact individuals' and families' day-to-day living as well as quality of life.[8 9] The overall economic cost of food allergy alone in the United States was estimated to be USD 24.8 billion annually or USD 4184 per child.[10] The total Medicare cost for out-of-hospital services related to food allergy in children aged 1 to 4 years in Melbourne, Australia alone was estimated at AUD 26.1 million annually.[11]

There are clear racial, ethnic, and socioeconomic disparities in allergic diseases worldwide.[12-14] Studies conducted on the burden of allergic disease in racially and ethnically structurally oppressed communities in Canada and the United States (US) showed an increased burden of allergic and atopic diseases (eczema, allergic rhinitis and asthma) among the Indigenous peoples of Canada.[15 16] In Australia, the burden of disease in general is 2.3 times higher among First Nations Australians,[17] and health outcomes are poorer when compared to Australians of other descents.[18] Asthma was the second most commonly reported long-term condition (16.6%) affecting First Nations Australians.[19 20] After adjusting for age difference, First Nations Australians were 1.6 times more likely to report having asthma compared to Australians of other descent.[21] However, there has been little research into other types of allergic disease in First Nations Australians.[22] In our study, the phrase 'First Nations Australians' respectfully refers to the Aboriginal and Torres Strait Islander peoples in Australia.[23]

Existing evidence from other countries suggests that disparities in the prevalence of allergic diseases exist between rural and urban areas. For example, a study conducted in South Africa reported a higher prevalence of self-reported allergies and a higher prevalence of objectively measured food allergy in

urban areas compared to rural areas.[24 25] This underscores the importance of conducting region-specific studies to inform targeted interventions and healthcare strategies. There has been little research into allergic disease in regional and rural areas of Australia. The lack of comprehensive data in these areas hinders our understanding of the unique factors influencing allergies in regional settings, including distinct environmental exposures and lifestyle variations. Although some evidence[26] suggests that certain allergies, including food allergies and eczema, may be less common in Northern Australia based on self-report, region-specific further studies are required to inform targeted interventions and healthcare strategies.

The current study endeavours to fill some of the existing evidence gaps by examining incidence rate and trends of ED presentations related to asthma and allergic diseases, both collectively and individually, among both First Nations Australians and Australians of other descents in Central Queensland, which encompasses both regional and rural and remote areas, from 2018 to 2023. The focus on asthma and allergic disease-related ED presentations in our study is guided by several key considerations. First, ED data provide a relatively accessible and reliable means to investigate asthma and allergic diseases without extensive logistical requirements. Moreover, ED data capture the burden of severe and life-threatening cases that necessitate immediate medical attention, highlighting the acute impact of these conditions. Such data are critical for identifying gaps in preventive care, timely access to treatment, and community health resources, particularly in regional, rural and remote areas. Furthermore, the acute care dimensions of asthma and allergic diseases, especially among Indigenous people in regional, remote and rural, are often overlooked in the literature. By addressing these aspects, our study aims to fill these gaps and complement existing prevalence-focused research.

Methods

Study design and settings

We conducted a retrospective analysis of routinely collected data from the Emergency Department Information System (EDIS) of Public Hospitals in Central Queensland (CQ), a regional district of

Queensland, Australia, located in the central east region (the study area map can be found in online Supplemental Figure 1).[27] The map was developed using the digital boundary files from the Australian Bureau of Statistics.[28] CQ encompasses rural and remote outback towns.[29] This study targeted the service catchment area of Central Queensland Hospital and Health Service (CQHHS) and included all patients presenting to the emergency department. CQHHS operates 12 public hospitals across various regions. These include 1) Rockhampton, Mount Morgan, and Capricorn Coast, situated within Inner Regional Australia, 2) Gladstone, Biloela, Emerald, Baralaba, Moura, Theodore, and Blackwater, which fall under Outer Regional Australia, and 3) Woorabinda and Springsure, located in Remote Australia.[30] [31] CQHHS also provides Aboriginal and Torres Strait Islander Health, Maternity services, CQ Cancer Care Services, Mental Health, Alcohol and Other Drugs Services, Oral Health and General Practitioner referrals.[30] Data from the 2021 national census show that the CQ region was populated by 228,246 people.[32] There were 59,070 families in CQ; the median age was 38 years and 64% of the population was aged between 15–64 years.[32] Over seven per cent (7.2%) of the total population in CQ identify as First Nations Australians.[32]

Participants

Our analysis included all ED presentation data from the CQHHS catchment areas, spanning January 2018 to November 2023, regardless of age or sex.

Variables

We described the overall asthma and allergic disease-related ED presentations using covariates available in the administrative data. These were self-reported Indigenous status (Aboriginal and/or Torres Strait Islanders, which are categorised into First Nations Australians, and not-Indigenous and not stated, which are categorised into Australians of other descents[33]), sex (female, male, and intersex), age group in years (≤ 4, 5-14, 15-29, 30-44, 45-59, 60+), hospital (Baralaba, Biloela, Blackwater, Emerald, Gladstone, Mount Morgan, Moura, Rockhampton, Springsure, Theodore, Woorabinda, and Yeppoon) as indirect indicator of place of residence.

Data source and measurement

Data were retrieved in a one-time extraction from the Business Analysis Decision Support (BADS) portal, deidentified, replaced with unique codes, and securely stored. The extraction was conducted by an experienced and expert data custodian following the CQHHS data extraction protocol. ED presentations related to asthma and allergic diseases were identified using the International Classification of Diseases-Tenth Revision-Australian Modification (ICD-10-AM) codes, as detailed in Supplemental Table 1. Given that not all asthma cases are necessarily allergic,[34 35] and considering that our dataset encompasses the ICD code J45.9, indicative of unspecified asthma, we presented asthma both independently and collectively with allergic diseases. This approach aims to clarify both the overall burden of asthma and allergic diseases collectively, as well as specific instances.

Statistical methods

We described participants' characteristics using frequency with per cent. P values were calculated using Pearson's χ^2 test, except in cases where the expected cell frequency was less than 5, where Fisher's Exact test was used. The incidence rates, with 95% confidence intervals (CIs), assuming a Poisson distribution, were calculated as the number of new asthma and allergic disease-related ED presentations per year divided by the total population of Central Queensland at risk during the same period. The total population of Central Queensland at risk per year was estimated as the total population of Central Queensland as reported by the Australian Bureau of Statistics.[36] The comparison of incidence and trends of asthma and allergic disease-related ED presentations over time was assessed using Poisson regression, presented as incidence rate ratios (IRRs) with corresponding 95% CIs. We used the goodness-of-fit chi-squared test to assess whether the Poisson model adequately fit our data. All P-values for these tests were not statistically significant (data not presented), suggesting that the Poisson model reasonably fits the observed data. Incidence rates specific to overall, indigenous status, and other available covariates, as described above, were presented.

Patient and public involvement

Patients and/or the general public were not involved in the design, or conduct, or drafting of this secondary analysis.

Results

There were a total of 813,112 ED presentations between January 2018 and November 2023, ranging from 1,248 (0.1%) in Baralaba to 303,138 (37.3%) in Rockhampton (Supplemental Table 2).

Background characteristics of patients presenting with asthma and allergic diseases

Table 1 presents the background characteristics of patients presenting to the ED due to asthma and allergic diseases. Statistically significant differences were observed in overall asthma and allergic disease-related ED presentations compared to presentations for other reasons, with a higher proportion of asthma and allergic disease-related ED presentations among females, children aged between 5-14, children aged under five, and across various hospital catchment areas (Table 1).

Incidence rates of asthma and allergic disease-related ED presentations

Overall, the rate of asthma and allergic disease-related ED presentations was 96.9 per 10,000 person-years (95% CI: 95.3, 98.6). There was a higher rate of asthma and allergic disease-related ED presentations among the First Nations Australians, which was 177.5 per 10,000 person-years (95% CI: 169.3, 186.0), compared to the incidence rate among Australians of other descents, which was 98.9 per 10,000 person-years (95% CI: 97.2, 100.8).

Table 2 illustrates the incidence rate of the specific case between 2018 and 2023. The four most common cases presenting to emergency departments were asthma (40.5/10,000 person-years, 95% CI: 39.4, 41.5), unspecified allergy (34.6/10,000 person-years, 95% CI: 33.6, 35.6), atopic/allergic contact dermatitis (10.3/10,000 person-years, 95% CI: 9.7, 10.8) and anaphylaxis and anaphylactic shock (5.8/10,000 person-years, 95% CI: 5.4, 6.2). There was a higher incidence rate of asthma, unspecified allergy, atopic/allergic contact dermatitis and allergic urticaria among First Nations

Australians compared to Australians of other descents. No food allergy presentations were reported in our data (Table 2).

Time trend of asthma and allergic disease-related ED presentations

Figure 1 presents the time trend in the rates of asthma and allergic disease-related ED presentations in Central Queensland. Except for the notable increase observed between 2018 and 2019, collective asthma and allergic disease-related ED presentations among First Nations Australians remained relatively stable. These rates ranged from 132.3 per 10,000 person-year (95% CI: 115.3, 151.1) in 2018 to 157.2 per 10,000 person-year in 2023 (95% CI: 138.6, 177.5; P=0.462). Similarly, rates of asthma and allergic disease-related presentations among Australians of other descents were nearly stable, varying from 94.0 per 10000 person-year (95% CI: 89.8, 98.4) in 2018 and 88.6 per 10000 person-year (95% CI: 84.5, 92.9, p =0.846) in 2023.

Figure 2 shows the time trend of ED presentation rates related to asthma and allergic disease separately. There was a significant increase in the rate of allergic diseases among First Nations Australians over time ($P\ value = 0.026$). Except for the peak observed in 2019 among First Nations Australians, asthma-related ED presentations remained relatively stable over time in both First Nations Australians and Australians of other descents.

Table 3 presents the total incidence of asthma and allergic disease-related ED presentations over the study period by gender and age group. The incidence rate of asthma and allergic disease-related ED presentations remained stable across indigenous status, gender, and age groups, with one exception. Among children aged 4 years or younger, there was a significant decline in the overall incidence of asthma and allergic disease-related ED presentations (IRR = 0.94, 95% CI: 0.91, 0.97, P<0.001) (Table 3).

Discussion

To the best of our knowledge, this is the first study to examine asthma and allergic disease-related ED presentations among both First Nations Australians and Australians of other descents in an understudied region of Australia, which encompasses both rural and remote outback towns. There was a significant increase in the rate of allergic disease-related ED presentations among First Nations Australians between 2018 and 2023. First Nations Australians in CQ experienced a significant rise in allergic diseases, with higher rates of ED presentations compared to Australians of other descents. Asthma, unspecified allergies, atopic/allergic contact dermatitis, and anaphylaxis/anaphylactic shock were the most common conditions observed in the ED presentations, with higher rates among First Nations Australians compared to Australians of other descents.

The higher rate of ED presentations related to allergic disease among First Nations Australians was surprising given that allergic and atopic diseases have not been traditionally recognised as an important concern among First Nations Australians.[37] Nevertheless, there is currently a growing recognition of this issue. Our findings highlight a substantial and potentially increasing burden of allergic disease among First Nations Australians living in a region encompassing regional, rural, and remote outback areas. This finding is in agreement with the findings of a study conducted in Canada and the US that showed an increased burden of allergic and atopic diseases among the Indigenous peoples of Canada.[15] Other previous studies conducted in the US and Australia, while lacking specific data on First Nations populations, also documented the existence of racial, ethnic, and socioeconomic disparities in food allergies.[12-14] Further studies are warranted to understand the underlying causes of these observed disparities.

There was a notable peak in recorded asthma-related ED presentations among First Nations Australians in 2019. This could be partially attributed to the bushfires that swept across Australia in 2019–20, also known as Black Summer, as asthma was one of the primary reasons for the ED presentations. Evidence shows that the national increase in emergency presentation and hospitalisation rates for asthma and chronic obstructive pulmonary disease (COPD) coincided with

increased bushfire activity during the 2019–20 bushfire season.[38] Bushfire smoke exposure was significantly associated with an increased risk of respiratory morbidity and other health impacts.[39 40] The notable spike in recorded asthma-related ED presentations could also be ascribed to the notably vigorous flu season in 2019,[41] which is recognised as one of the triggers for an asthma attack.[42]

The primary reason for ED presentations was asthma, with a significantly higher incidence observed among First Nations Australians compared to Australians of other descents. Within our dataset, asthma cases could encompass both allergic and non-allergic variants. The higher incidence of asthma-related ED presentations could reflect either an increased prevalence of asthma or asthma exacerbations in First Nations Australians and/or an increased propensity of First Nations Australians to present to ED for asthma exacerbations due to socioeconomic or other factors. Literature documented that First Nations Australians were 1.6 times more likely to report having asthma in 2018-19 compared with Australians of other descents.[43] Another study that used birth, hospital and ED for all First Nations Australian children born between 2003 and 2012 in Western Australia reported that 2.7% of children had been hospitalised for asthma at least once between the ages of 1 and 4 years.[44] The higher incidence of asthma-related ED presentation could be multifactorial including first time/ unrecognised asthma, unmet medical need, unsuccessful/inadequate home management, medication non-adherence, exacerbation triggered by environmental factors, including bushfire, environmental pollution, and risky health behaviours such as smoking. Literature has documented that nearly half (47%) of the respiratory disease burden among First Nations Australians in 2018 was linked to smoking.[45] The lack of access to culturally appropriate asthma education and healthcare services could also contribute to the higher incidence of asthma-related ED presentations among First Nations Australians.[46]

Atopic/allergic contact dermatitis ranked as the third most common cause for ED visits, with a higher rate noted among First Nations Australians compared to Australians of other descents. A 5-year retrospective audit of all outpatient encounters with a visiting dermatology specialist in the Kimberley

region of Western Australia reported that eczema/dermatitis was the primary condition seen in First Nations Australians (19%) and third most common in Australians of other descents (17%).[47] Another study conducted in Melbourne between 2009 and 2011 reported that 3.9% of ED presentations were due to skin complaints, of which eczema/dermatitis was the fourth most common dermatological condition although data on the indigenous status of the study population[48] was not reported. It is documented that atopic dermatitis is associated with a higher risk of other atopic disorders, including asthma, hay fever, food allergy, and eosinophilic esophagitis.[49] It is also a known risk factor for streptococcal skin infection[49-52] and subsequent systemic and life-threatening complications including sepsis, endocarditis, and bone and joint infections if left untreated.[49 53-55] For instance, a study at the Wuchopperen Clinic in Cairns, Far North Queensland, found that 73.7% of children and youths treated for skin infections tested positive for group A streptococcus.[56]

We found that anaphylaxis/anaphylactic shock was the fourth most common cause of allergy related ED presentations. Previous studies conducted in Australia[57 58] documented an increase in the rate of anaphylaxis over time although they lack data based on indigenous status. A study conducted in Victoria reported that the causes of anaphylaxis-related ED presentations were foods (62%); drugs (12%), insect venoms (8%), and other causes (4%).[59] The current study lacked data to specify the causes of anaphylaxis/ anaphylactic shock. Interestingly, there were no food allergy presentations recorded in our data. However, it is possible that a substantial portion of the unspecified allergies, which was the second most frequent cause of ED presentations, may be linked to food allergies. Further studies are required to fill this evidence gap in our study area.

There was a twofold higher rate of allergic urticaria-related ED presentations, which ranked as the fifth leading cause of ED visits, among First Nations Australians compared to their counterparts. A study conducted in Italy reported that acute urticaria in 1 year accounted for 1.01% of total ED visits and 1.2 admissions per day [60] and drugs, insect bites, foods and contact urticaria were the most common triggers identified. With a presumption that allergic urticaria that results in ED presentation

in our study is acute urticaria [61], literature documented its risk factors including high population density,[62] personal[63] and parental history of allergic diseases,[64 65] poverty and lower socio-economic status.[62 66] Further studies are required to understand risk factors associated with allergic urticaria, particularly among First Nations Australians.

Strengths of the study include the use of the most recent, large data set including both First Nations Australians and Australians of other descents and all age groups from a study setting encompassing regional, rural, and remote outback areas. As a limitation, the reporting of ED presentations related to asthma and allergic disease relies on the ICD codes entered by physicians at the time of presentation. Our study specifically focused on asthma and allergic disease-related ED presentations and did not encompass all instances of acute asthma and allergic diseases in the general population which may visit health facilities in routes other than ED. Caution should be taken when generalising our results to the broader population, as they may not fully reflect the overall incidence of asthma and allergic diseases in the community but asthma and acute allergic disease resulting in ED visits only. Our analyses were limited to factors available in the administrative data, not comprehensively incorporating other important factors, including socioeconomic status, which encompasses education, financial resources, social standing, access to transportation, mobile phones, the internet, housing conditions, and geographic location,[67] comorbidities, time of first allergy diagnosis, family history of allergies, obesity/overweight, smoking status, and environmental factors among others. For instance, literature has documented that social disadvantage impacts many aspects of allergic disease, including healthcare access, prevalence, and outcomes.[12 68] Therefore, further research is needed to explore the overall incidence of asthma and allergic diseases, considering a comprehensive set of potential confounders, to provide a more thorough understanding of both overall allergy incidence and its associated factors. Also, it is important to note that our study relied on the accurate reporting of individuals' indigenous status in medical records.

Conclusion

Our findings highlight a significantly higher rate of asthma and allergic disease-related ED presentations among First Nations Australians compared to Australians of other descents in Central Queensland. This underscores the urgent need for further research to understand the causality and targeted healthcare interventions integrating a culturally sensitive approach.

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Contributors

All authors (DMS, MHA, DM, RW, PDS, CFM, RLP, GK, JJK) contributed to the design of the study and the interpretation of data. DMS performed the data analysis and drafted the manuscript. All authors (DMS, MHA, DM, RW, PDS, CFM, RLP, GK, JJK) read, revised, and approved the final manuscript. DMS acted as the guarantor.

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Competing interests

All other authors have no competing interest to declare.

Patient consent for publication

Not required.

Ethics approval

We obtained ethics approval from the Human Research Ethics Committee (HREC) of the Central Queensland Hospital and Health Service (CQHHS) (Reference Id: 101806). Owing to the retrospective design of this study and its reliance on routinely collected hospital administrative data for medical services, seeking individual consent was deemed unnecessary.

Data availability statement

Data are not publicly available and may be obtained from a third party. Deidentified patient data can be requested from the Central Queensland Hospital and Health Service (CQHHS).

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Figure Legends

Figure 1. Incidence of both asthma and allergic disease-related Emergency Department presentations in Central Queensland between 2018 and 2023
ED= Emergency Department

Figure 2. Separate incidence of asthma and allergic disease-related Emergency Department presentations in Central Queensland between 2018 and 2023
ED= Emergency Department

Table 1. Background characteristics of patients presenting with asthma and allergic diseases compared to individuals presenting to ED for other reasons (N=813112)

Variable		Asthma and allergic disease-related ED presentations		P value
		No	Yes	
Indigenous status (n=812995)				
	First Nations Australians	107099 (98.4)	1755 (1.6)	0.569
	Australians of other descent /Not Stated	692623 (98.4)	11518 (1.6)	
Sex				
	Female	397513 (98.2)	7395 (1.8)	< 0.001
	Male	402219 (98.6)	5879 (1.4)	
	Intersex	106 (100.0)	0 (0.0)	
Age group (Year, n=813111)				
	≤4	78484 (97.5)	2018 (2.5)	< 0.001
	5-14	87248 (97.2)	2540 (2.8)	
	15-29	180778 (98.4)	2905 (1.6)	
	30-44	148,015 (98.5)	2285 (1.5)	
	45-59	129214 (98.4)	2051 (1.6)	
	60+	176,098 (99.2)	1475 (0.8)	
Hospital				
	Baralaba	1234(98.9)	14(1.1)	<0.001
	Biloela	41009(98.0)	853(2.0)	
	Blackwater	25048 (98.1)	474 (1.9)	
	Emerald	83599(98.6)	1216 (1.4)	
	Gladstone	203136(98.2)	3618(1.8)	
	Mount Morgan	15972(98.1)	301(1.9)	
	Moura	12457(98.1)	241(1.9)	
	Rockhampton	298827(98.6)	4311(1.4)	
	Springsure	7983(98.2)	144(1.8)	
	Theodore	1414(98.7)	19(1.3)	
	Woorabinda	12894(98.2)	239(1.8)	
	Yeppoon	96265(98.1)	1844(1.9)	

ED= Emergency Department

Table 2. Incidence rate of asthma and allergic diseases from 2018 to 2023.

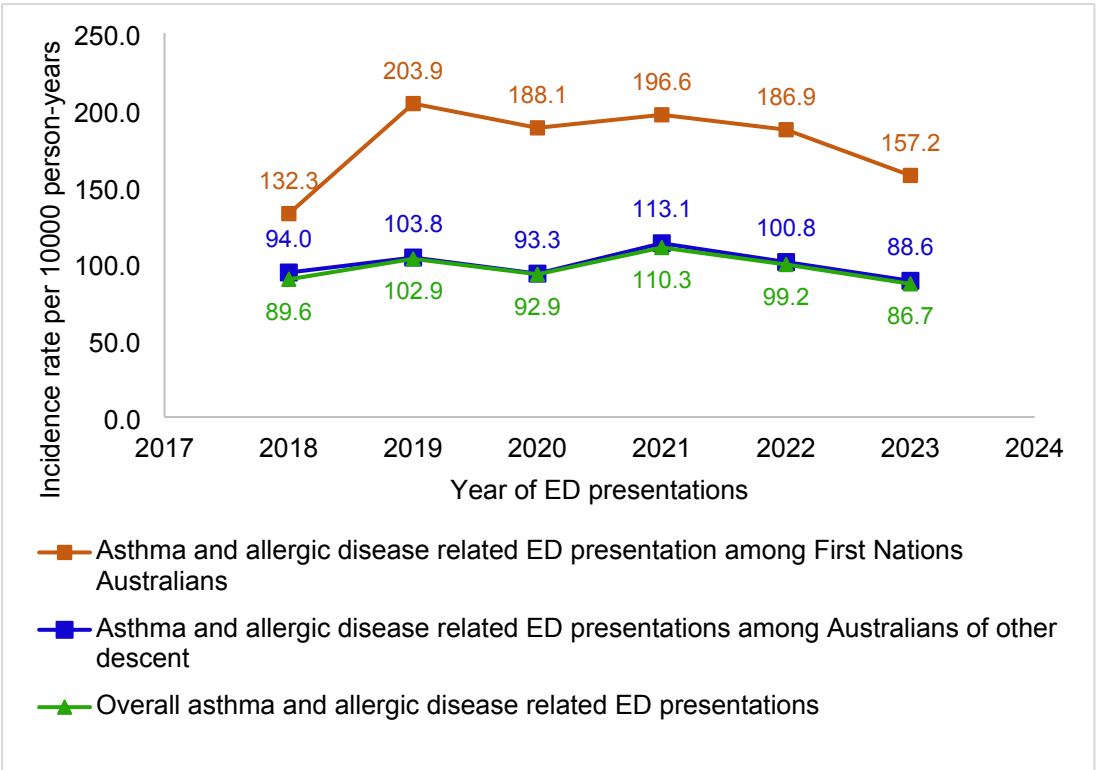
Asthma and allergic diseases	Asthma and specific type of allergy (per 10000 person-year with 95% CI)		
	First Nations Australians	Australians of other descent	Overall
Asthma*	87.8 (82.0, 93.8)	40.2 (39.0, 41.3)	40.5 (39.4, 41.5)
Unspecified allergy*	55.3 (50.8, 60.2)	36.0 (34.9, 37.1)	34.6 (33.6, 35.6)
Atopic/allergic contact dermatitis*	17.1 (14.6, 19.9)	10.6 (10.0, 11.2)	10.3 (9.7, 10.8)
Anaphylaxis and anaphylactic shock	7.2 (5.6, 9.1)	6.2 (5.7, 6.6)	5.8 (5.4, 6.2)
Allergic urticaria*	4.0 (2.9, 5.5)	2.3 (2.1, 2.6)	2.3 (2.0, 2.5)
Allergic conjunctivitis*	3.6 (2.5, 5.0)	2.4 (2.1, 2.7)	2.3 (2.1, 2.6)
Allergic rhinitis*	1.9 (1.2, 3.0)	0.7 (0.6, 0.9)	0.8 (0.6, 0.9)
Allergic purpura	0.5 (0.2, 1.2)	0.5 (0.4, 0.7)	0.5 (0.4,0.6)
Overall allergic diseases*, **	89.7 (83.9, 95.8)	58.8 (57.4, 60.2)	56.4 (55.2, 57.7)

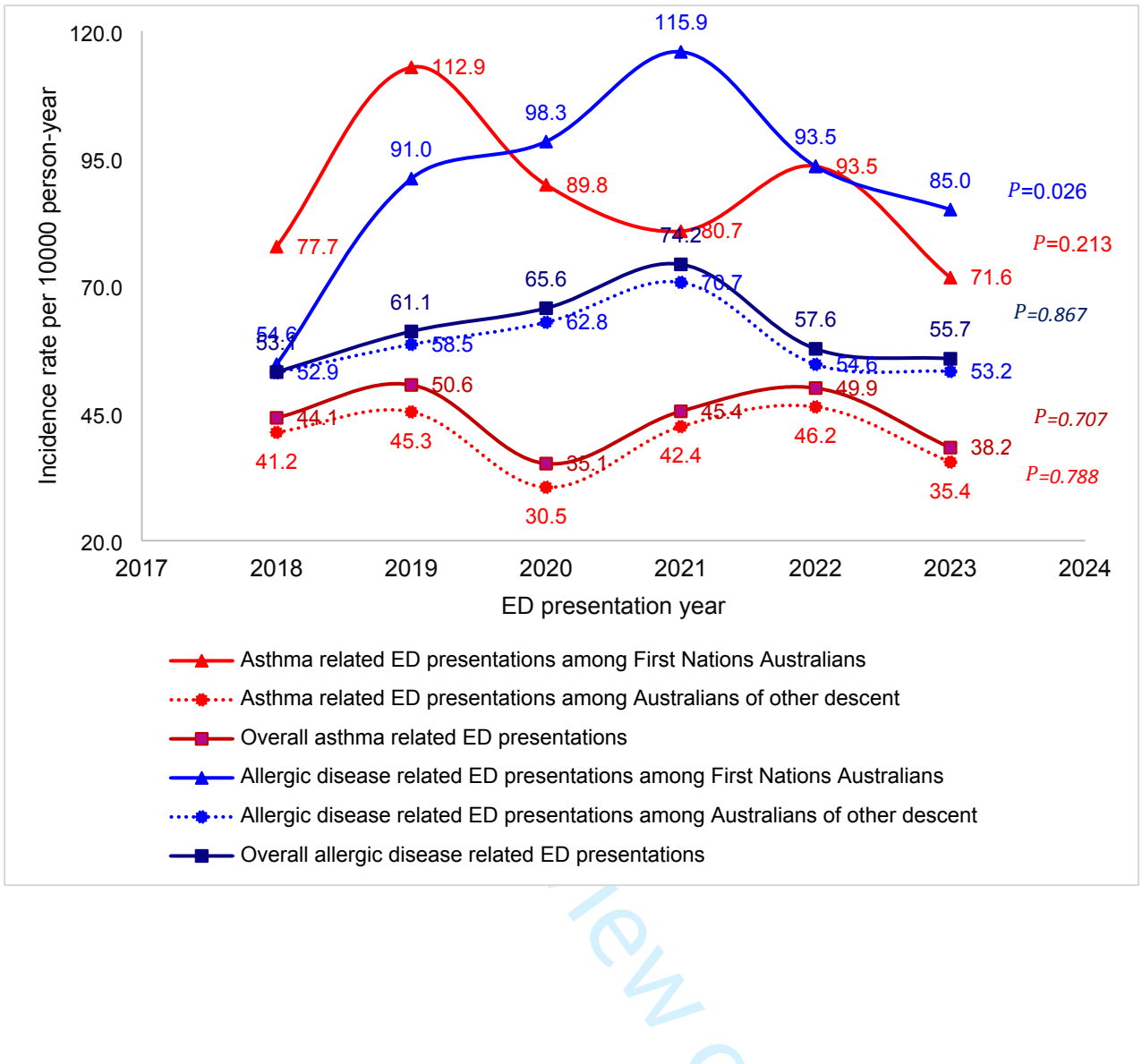
**P* value < 0.05 when comparing the incidence rate per person-year between First Nations Australians and Australians of other descent, ****Overall allergic diseases encompass all specific allergic diseases, including unspecified allergy, atopic/allergic contact dermatitis, anaphylaxis, and anaphylactic shock, allergic urticaria, allergic conjunctivitis, allergic rhinitis, and allergic purpura but not asthma

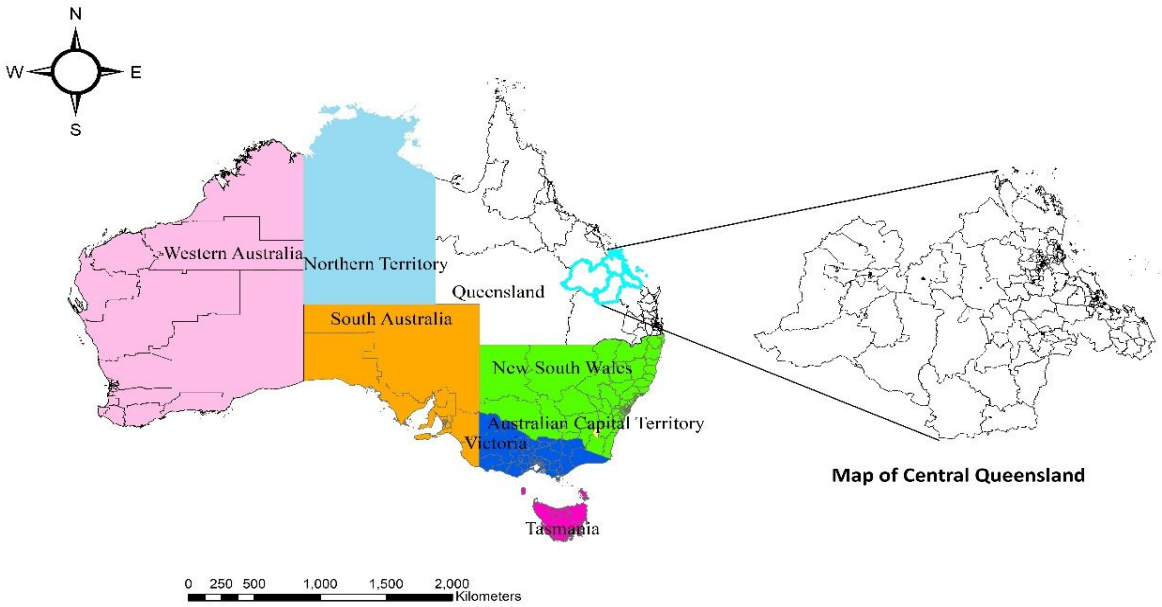
Table 3. Incidence of asthma and allergic disease-related ED presentations (per 10,000 person-years) from 2018 to 2023

Year	Asthma and allergic disease-related ED presentations							
	Sex*		Age (Year)					
	Female	Male	0-4	5-14	15-29	30-44	45-59	60+
2018	101.2	78.2	281.6	111.9	99.0	75.0	64.5	47.9
2019	116.7	89.4	262.6	147.8	119.0	77.5	82.5	55.4
2020	105.4	80.7	208.9	105.0	108.9	98.3	80.5	44.7
2021	123.6	97.2	240.7	134.2	138.5	100.1	95.3	57.0
2022	111.9	86.9	222.3	134.2	135.6	84.2	74.5	46.3
2023	96.6	76.9	208.2	133.0	97.4	76.6	60.9	44.5
IRR (95% CI)	0.99 (0.95, 1.04)	1.001 (0.951, 1.053)	0.94 (0.91, 0.97)	1.02 (0.97, 1.06)	1.02 (0.97, 1.06)	1.01 (0.96, 1.06)	0.98 (0.93, 1.04)	0.98 (0.91, 1.05)
P value	0.824	0.974	<0.001	0.320	0.432	0.700	0.710	0.587

ED= Emergency Department, IRR= Incidence rate ratio, CI= Confidence interval, *Intersex is not included in this table, as no cases of asthma or allergic disease were reported, as shown in Table 1.







Supplemental Figure 1. Locator map of the study area.

Source: The map was developed using the digital boundary files from the Australian Bureau of Statistics.

Supplemental Table 1. ICD-10-AM codes related to allergic conditions.

Condition	ICD-10-AM Code
Allergy, unspecified	T78.4, Z91.0
Allergic atopic dermatitis	L20, L20.8, L20.9
Allergic contact dermatitis	L23, L23.0-L23.9
Allergic conjunctivitis	H10.1, H10.2, H10.3, H10.4,
Allergic gastroenteritis	K52.2
Allergic purpura	D69.0
Allergic rhinitis	J30, J30.1, J30.2, J30.3, J30.4, J30.5
Allergic urticaria	L50.0, L50.8
Anaphylaxis	T78.0, T78.1, T78.2, T80.5, T88.6
Asthma	J45.0, J45.8, J45.9, J46
Food allergy	Y37.0-Y37.9, Y37.2, Y37.20, Y37.21, Y37.22, Y37.23, Y37.29, Y37.3, Y37.30, Y37.31, Y37.32, Y37.39, Y37.4, Y37.5

Supplemental Table 2. Emergency Department presentations at Public Hospitals in Central Queensland, 1 January 2018 to 30 November 2023 (N=813, 122)

Hospital	Year Frequency (%)						
	2018	2019	2020	2021	2022	2023	Total
Baralaba	X	X	X	237 (19.0)	547 (43.8)	464 (37.2)	1248 (100.0)
Biloela	6549 (15.6)	6394 (15.3)	7312 (17.5)	7268 (17.4)	7294 (17.4)	7045 (16.8)	41862 (100.0)
Blackwater	1207 (4.7)	5184 (20.3)	4453 (17.5)	4651 (18.2)	4752 (18.6)	5275 (20.7)	25522 (100.0)
Emerald	12320 (14.5)	13129 (15.5)	13110 (15.5)	16036 (18.9)	15639 (18.4)	1458 (17.2)	84815 (100.0)
Gladstone	31065 (15.0)	34340 (16.6)	36627 (17.7)	36349 (17.6)	36209 (17.5)	32164 (15.6)	206754 (100.0)
Mount Morgan	805 (4.9)	2925 (18.0)	2820 (17.3)	3280 (20.2)	3448 (21.2)	2995 (18.4)	16273 (100.0)
Moura	481 (3.8)	2158 (17.0)	2410 (19.0)	3118 (24.5)	2603 (20.5)	1928 (15.2)	12698 (100.0)
Rockhampton	47270 (15.5)	50522 (16.7)	49869 (16.5)	55777 (18.4)	52708 (17.4)	46992 (15.5)	303138 (100.0)
Springsure	337 (4.1)	1565 (19.3)	1697 (20.9)	1644 (20.2)	1535 (18.9)	1349 (16.6)	8127 (100.0)
Theodore	X	X	X	290 (20.2)	586 (40.9)	557 (38.9)	1433 (100.0)
Woorabinda	380 (2.9)	2107 (16.0)	2497 (19.0)	2476 (18.9)	2903 (22.1)	2770 (21.1)	13133 (100.0)
Yeppoon	14540 (14.8)	15017 (15.3)	15500 (15.8)	19797 (20.2)	17577 (17.9)	15678 (16.0)	98109 (100.0)
Total	114954 (14.1)	133341 (16.4)	136295 (16.8)	150923 (18.6)	145801 (17.9)	131798 (16.2)	813112 (100.0)

X= ED services were not available.