

# Frequent Avoidable Admissions Amongst Aboriginal and Non-Aboriginal People with Chronic Disease in New South Wales, Australia: A Retrospective Cohort Study

Amanda Anne Jayakody (✉ [amanda.jayakody@uon.edu.au](mailto:amanda.jayakody@uon.edu.au))

University of Newcastle <https://orcid.org/0000-0001-9123-1514>

Christopher Oldmeadow

University of Newcastle

Mariko Carey

University of Newcastle

Jamie Bryant

University of Newcastle

Tiffany Evans

University of Newcastle

Stephen Ella

Central Coast Local Health District

John Attia

University of Newcastle

Simon Towle

James Cook University

Robert Sanson-Fisher

University of Newcastle

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## Research article

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# Abstract

**Background:** Aboriginal and Torres Strait Islander people have high rates of avoidable hospital admissions for chronic diseases, however little is known about the frequency of avoidable admissions for this population. This study aimed to examine trends in avoidable admissions among Aboriginal and non-Aboriginal people with ambulatory care sensitive chronic conditions in New South Wales (NSW), Australia.

**Methods:** A retrospective cohort analysis using de-identified linked administrative data of Aboriginal and non-Aboriginal patients between 2005/06 to 2013/14. Eligible patients were admitted to a NSW public hospital and who had one or more of the following ambulatory care sensitive chronic conditions as a principal diagnosis: diabetic complications, asthma, angina, hypertension, congestive heart failure and/or chronic obstructive pulmonary disease. The primary outcomes were the number of avoidable admissions for an individual in each financial year, and whether an individual had three or more admissions compared with one to two avoidable admissions in each financial year. Poisson and logistic regression models and a test for differences in yearly trends were used to assess the frequency of avoidable admissions over time, adjusting for sociodemographic variables and restricted to those aged  $\leq 75$  years.

**Results:** There were a total of 27,467 avoidable admissions corresponding to 19,025 patients over the nine-year period (71.2% Aboriginal; 28.8% non-Aboriginal). Aboriginal patients were 15% more likely than non-Aboriginal patients to have a higher number of avoidable admissions per financial year (IRR=1.15; CI: 1.11, 1.20). Aboriginal patients were almost twice as likely as non-Aboriginal patients to experience three or more avoidable admissions per financial year (OR=1.90; CI=1.60, 2.26). There were no significant differences between Aboriginal and non-Aboriginal people in yearly trends for either the number of avoidable admissions, or whether or not an individual experienced three or more avoidable admissions per financial year ( $p=0.8599$ ;  $0.8608$  respectively).

**Conclusion:** Aboriginal people were significantly more likely to experience frequent avoidable admissions over a nine-year period compared to non-Aboriginal people. These high rates reflect the need for further research into which interventions are able to successfully reduce avoidable admissions among Aboriginal people with chronic diseases, and the importance of culturally appropriate early prevention and community health care.

## Background

The term “avoidable admissions”, also known as potentially preventable hospitalisations, refers to hospital admissions for ambulatory care sensitive conditions. Such conditions are considered manageable through timely and effective primary care.[1] Internationally, and in Australia, the concept of avoidable admissions is used as an indicator of health system performance.[1–3] Chronic conditions which are ambulatory care sensitive include (but are not limited to) chronic obstructive pulmonary disease, diabetic complications and congestive heart failure.

Aboriginal and Torres Strait Islander people (Aboriginal people hereinafter)<sup>1</sup> have a higher prevalence of chronic conditions and higher rates of avoidable admissions for chronic conditions compared to non-Aboriginal Australians.[2, 4] Within the Australian state of New South Wales (NSW) avoidable admission rates for chronic diseases are more than three times higher among Aboriginal people compared to non-Aboriginal people.[3, 5] Of particular importance is the fact that these higher rates have remained consistent over the past decade.[6]

Among those who experience avoidable hospital admissions, there is a subset of people who are particularly vulnerable due to the frequency of avoidable admissions experienced. Frequent avoidable admissions to hospital are a significant and complex issue facing health services internationally.[7–9] The definition of frequent avoidable admissions varies in the literature, with cut off points at three or four admissions within a 12 months period used.[7–10] However, the most widely reported definition uses three or more admissions within 12 months.[7, 10, 11] Frequent avoidable admissions are associated with a higher risk of an unplanned readmission and are an indication of poor chronic disease management within the community setting.[2, 10, 11] Frequent avoidable admissions are a costly burden on the health system and are a significant cause of bed shortages in hospitals.[7, 9] People who experience frequent avoidable admissions may experience poor quality of life, high out of pocket expenses, psychological distress; and for those most vulnerable patients, frequent admissions can put them at risk of hospital acquired infection.[12–14]

The very few research studies that have examined frequent admissions show that Aboriginal people are significantly more likely to experience frequent emergency department presentations and frequent admissions to hospital compared with non-Aboriginal people.[8, 15, 16] A South Australian prevalence study from 2005 to 2011 examining avoidable admissions using linked administrative public hospital record data found that Aboriginal people hospitalised with a chronic condition went on to experience on average 2.6 avoidable admissions in the next 12 months compared to 1.9 avoidable admissions among non-Aboriginal people.[17] Another study examined all inpatient episodes, rather than just avoidable chronic condition admissions, in Northern Territory public hospitals between 2005 and 2013.[8] Springer and colleagues found that frequent admissions were more common among Aboriginal people (crude odds ratio = 2.50 (95% CI. 2.41–2.59)) compared to non-Aboriginal people, and mostly due to respiratory diseases and injury and poisoning.[8] It is not clear how generalizable the results from these studies are to other Australian states such as NSW which has the largest population of Aboriginal and Torres Strait Islander people in Australia.[18] Relatively little is known about frequent avoidable admissions for Aboriginal people with chronic conditions in NSW.

Examining trends over time in frequent avoidable admissions among Aboriginal people with ambulatory care sensitive chronic conditions has the potential to inform strategies aimed at improving community based chronic disease management. This study examined trends in avoidable admissions among Aboriginal and non-Aboriginal people with ambulatory care sensitive chronic conditions admitted to NSW hospitals between 2005/6 and 2013/14.

## Methods

### Study design

A retrospective cohort with de-identified linked hospital and administrative data.

### Data sets

Records were drawn from the NSW Admitted Patient Data Collection (APDC; representing all separations in public and private hospitals in NSW, including discharges, transfers and deaths); and the NSW Registry of Births, Deaths and Marriages (RBDM) providing fact of death.

### Study cohort

The study cohort comprised patients who: were aged 18 years and older at the time of index admission; were admitted to a NSW public hospital; discharged from hospital to the community; and had one or more of the following selected ICD-10 defined ambulatory care sensitive (ACS) chronic diseases as a principle diagnosis: diabetic complications, asthma, angina, hypertension, congestive heart failure (CHF) and/or chronic obstructive pulmonary disease (COPD) (Additional File 1). These chronic conditions were selected as they are highly prevalent among Aboriginal people and an admission to hospital relating to these chronic conditions is considered potentially avoidable through health promotion, preventative measures, or timely access to non-hospital care such as through community health care.[2, 3]

### Sampling

All patients meeting the eligibility criteria who had at least one APDC record during the study period, and where status was recorded as Aboriginal and/or Torres Strait Islander person on any APDC record were selected. A non-Aboriginal comparison sample was selected by using an equal number of randomly sampled patients who met the eligibility criteria and had no APDC records with Aboriginality coded as 'yes'. RBDM death records which linked to the sample of Aboriginal and non-Aboriginal patients were extracted and included in the final sample.

### Data preparation

Access to the relevant NSW datasets was through the Centre for Health Record Linkage (CHerEL) who linked the data using probabilistic record linkage methods.[19] All data were provided in a de-identified format. Duplicate records were excluded. Periods of care were defined as overlapping episodes of care and sequential transfers were considered in order to define the start and end dates for the period of continuous hospital care. A period of care ended with discharge from hospital. If a patient was discharged and then readmitted the same day, this represented the next period of care. Periods of care in the year of an individual's death were included in the analysis. Periods of care are referred to as admissions for the remainder of this paper. Two datasets were prepared for analysis: an un-aggregated database of admissions with a defined ACS ICD code ( $n = 31,836$ ) and an aggregated dataset of counts

of the number of avoidable admissions for each patient by financial year, and whether they were planned or unplanned admissions (n = 22,802).

## Exclusions

Private hospital admissions were excluded from the cohort. It was a priori acknowledged that most private hospital admissions are planned as very few private hospitals have emergency departments, and private patients who experience frequent admissions would have a different sociodemographic profile to those in public hospitals. Planned admissions were excluded from the analysis.

## Analysis variables

For each individual the following outcomes were used: 1) the number of avoidable admissions (defined as an unplanned admission with a principal diagnosis of an ACS chronic condition) for an individual in each financial year; 2) whether or not an individual experienced three or more avoidable admissions in each financial year they were observed over the study period (compared with one to two avoidable admissions). Unplanned admissions were coded as an “emergency status recode” in the APDC.

## Explanatory variables

The sociodemographic and disease related variables listed below for each individual in each financial year corresponded to those recorded at the first avoidable admission (except for Aboriginal status).

1. Sociodemographic variables: Patient’s gender, age, Aboriginal status and marital status. The Accessibility/Remoteness Index of Australia (ARIA) and the Index of Relative Socio-economic Disadvantage (IRSD) quintile were also included. ARIA is the standard Australian Bureau of Statistics (ABS) endorsed measure of remoteness and is derived from measures of road distances between populated localities and service centres.[20] The IRSD is a general socio-economic index that summarises a range of information about the economic and social conditions of people and households within a geographic area.[21]
2. Disease-related variables: the mean Charlson Co-morbidity Index (CCI) was included.[22] The CCI is an index of the risk of mortality from comorbidity during the next 12 months and calculates a score from secondary diagnoses of admissions weighted for type of condition.
3. Admission variables: The following variables were collected for each hospital admission: financial year of separation and length of stay.

## Statistical analysis

The denominator for the analysis was all avoidable admissions which met the eligibility criteria. At the admission level (unaggregated data), chi-square and t-tests were used to examine crude associations between Aboriginal status and sociodemographic, disease and admission factors. Then at the patient level (aggregated data), the yearly means of avoidable admissions were calculated by Aboriginal status and financial year. Chi-square tests were then used to examine associations of the proportion of

individuals with three or more avoidable admissions compared with one to two avoidable admissions by Aboriginal status and financial year. Multivariable analyses were conducted using the aggregated data. Firstly, a Poisson regression model was used to examine the association of the number of avoidable admissions and Aboriginal status controlling for age, sex, marital status, financial year, IRSD, ARIA and restricted to patients aged  $\leq 75$  to account for the younger age structure of the Aboriginal patients. Secondly, a logistic regression model was used to assess the association of three or more avoidable admissions compared with one to two per financial year and Aboriginal status, controlling for age, sex, marital status, financial year, IRSD, ARIA and restricted to patients aged  $\leq 75$ . To examine any differences in yearly trend between Aboriginal and non-Aboriginal people, an interaction term for Aboriginal status and financial year (as a categorical variable) was included in both final models, followed by a post estimation Wald test of the interaction term. The model was also fit without the interaction term and a post estimation Wald test was used to test the significance of the financial year term. A sensitivity analysis was conducted to examine any potential differences in results when indices ending in death were excluded. Stata software was used for all analyses.[23]

## Ethics approval

The study was approved by the NSW Population & Health Services Research Ethics Committee (HREC/15/ CIPHS/18) and the NSW Aboriginal Health and Medical Research Council Ethics Committee (1090/15).

## Results

Once all the eligibility criteria had been applied to the linked dataset (Fig. 1), there was a total of 27,467 avoidable admissions ( $n = 20,306$  Aboriginal;  $n = 7,161$  non-Aboriginal) between the study period 2005/06 to 2013/14.

<insert Fig. 1 - Flow diagram of dataset generation>

## Characteristics of people with avoidable admissions

Table 1 describes the characteristics of people with avoidable admissions by Aboriginal status at the admission level between 2005/06 to 2013/14. There were statistically significant differences between Aboriginal and non-Aboriginal patients who experienced avoidable admissions. Aboriginal patients were significantly younger, with an average age of 57 years compared with 70 years in non-Aboriginal people. Aboriginal patients were more likely to be female compared with non-Aboriginal patients, and more likely to be single and divorced. Aboriginal patients had a significantly higher proportion of diabetic complications, asthma and COPD, while non-Aboriginal patients had a significantly higher proportions of angina, hypertension and CHF. Aboriginal patients were also more likely to be socially disadvantaged and live remotely. Lastly, non-Aboriginal patients had a significantly higher mean length of stay in hospital compared to Aboriginal patients.

Table 1  
 Characteristics of avoidable admissions by Aboriginal status (admission level) (n = 27,467)

		<b>Aboriginal % (n) (n = 20,306)</b>	<b>Non- Aboriginal % (n) (n = 7,161)</b>	<b>χ<sup>2</sup> p-value</b>
<b>Sex</b>	% Male	43.9 (8921)	51.5 (3691)	< 0.0001
<b>Age</b>	Mean (SD)	57.0 (14.9)	69.8 (16.1)	< 0.0001
<b>Marital status</b>				< 0.0001
	Married/de facto	37.1 (7540)	49.7 (3556)	
	Single	29.7 (6023)	11.4 (815)	
	Widowed	15.5 (3148)	26.5 (1898)	
	Divorced/separated	16.0 (3255)	11.4 (813)	
	Not known	1.6 (327)	1.1 (75)	
<b>ACS chronic diseases</b>	Diabetic complications	18.4 (3746)	13.0 (930)	< 0.0001
	Asthma	11.4 (2309)	8.7 (626)	< 0.01
	Angina	17.1 (3466)	20.3 (1452)	< 0.001
	Hypertension	2.4 (493)	3.5 (252)	< 0.001
	CHF	11.2 (2274)	22.5 (1609)	< 0.0001
	COPD	39.5 (8018)	32.0 (2292)	< 0.0001
<b>Charlson co-morbidity Index</b>	Mean (SD)	1.3 (1.4)	1.4 (1.4)	0.0937
<b>IRSD</b>				< 0.0001
	1st quintile - most disadvantaged	29.2 (5939)	13.0 (933)	

		<b>Aboriginal % (n) (n = 20,306)</b>	<b>Non- Aboriginal % (n) (n = 7,161)</b>	<b>χ<sup>2</sup> p-value</b>
	2nd quintile	29.9 (6080)	25.4 (1821)	
	3rd quintile	20.7 (4195)	23.0 (1645)	
	4th quintile	16.4 (3329)	21.4 (1535)	
	5th quintile - least disadvantaged	3.8 (763)	17.1 (1227)	
<b>ARIA</b>				< 0.0001
	Highly Accessible	33.5 (6811)	64.9 (4647)	
	Accessible	37.5 (7616)	26.6 (1902)	
	Moderately Accessible	19.2 (3897)	7.3 (525)	
	Remote / Very Remote	9.8 (1982)	1.2 (87)	
<b>Length of stay</b>	Mean (SD)	5.4 (11.3)	6.6 (13.2)	< 0.0001

<insert Table 1 here - Characteristics of avoidable admissions by Aboriginal status (admission level) (n = 27,467)>

## The number of avoidable admissions by Aboriginal status and financial year

At the patient level, the dataset contained a total of 19,025 patients who had experienced avoidable admissions, of which 71.2% were Aboriginal (n = 13,549) and 28.8% were non-Aboriginal (n = 5,476). Averaged across the whole nine-year period, Aboriginal patients had a higher mean of avoidable admissions (Mean = 1.50, Standard deviation = 1.26) compared with non-Aboriginal patients (Mean = 1.30, Standard deviation = 0.84), and this difference remained stable over the study period (Fig. 2).

<Insert Fig. 2: Mean number of avoidable admissions by Aboriginal status and financial year (n = 19,025).>

### Three or more avoidable admissions per financial year

Table 2 demonstrates the proportion of patients with three or more compared to one to two avoidable admissions each financial year by Aboriginal status. Aboriginal people had a consistently and significantly higher proportion of frequent avoidable admissions over the study period compared with non-Aboriginal people.

Table 2  
Proportion of patients with three or more compared to one to two avoidable admissions by Aboriginal status and financial year (n = 19,025).

Financial year of admission	Aboriginal (n = 13,549)		Non-Aboriginal (n = 5,476)		p-value
	% (n)		% (n)		
	1-2	3+	1-2	3+	
2005/06	88.4 (1,102)	11.6 (145)	93.6 (496)	6.4 (34)	0.001
2006/07	89.4 (1,139)	10.6 (135)	93.2 (549)	6.8 (40)	0.009
2007/08	89.0 (1,234)	11.0 (152)	95.4 (585)	4.6 (28)	< 0.0001
2008/09	90.5 (1,279)	9.5 (134)	92.6 (525)	7.4 (42)	0.142
2009/10	88.9 (1,317)	11.1 (165)	93.8 (515)	6.2 (34)	0.001
2010/11	88.9 (1,247)	11.1 (156)	94.3 (525)	5.7 (32)	< 0.0001
2011/12	88.8 (1,400)	11.2 (177)	93.5 (560)	6.5 (39)	0.001
2012/13	89.5 (1,343)	10.5 (157)	93.9 (543)	6.1 (35)	0.002
2013/14	88.9 (1,431)	11.1 (179)	92.4 (561)	7.6 (46)	< 0.05

## Regression analyses

At the patient level, unadjusted Poisson regression models were calculated for the number of avoidable admissions for each financial year of the study period (Table 3). Once adjusted for financial year, sex, age, marital status, IRSD and ARIA, Aboriginal patients were 16% more likely than non-Aboriginal patients to have a higher number of avoidable admissions per financial year (IRR = 1.16; CI: 1.13, 1.20). As the age structure of Aboriginal patients was significantly younger, the model was then restricted to patients aged 75 years or less; however Aboriginal patients remained significantly more likely to have more avoidable admissions per financial year (IRR = 1.15; CI: 1.11, 1.20). An interaction term between Aboriginal status and financial year was added to the model which demonstrated no significant difference between Aboriginal and non-Aboriginal people in yearly trends in the number of avoidable admissions each year over the study period (Post estimation Wald test,  $p = 0.8608$ ). As the interaction was not significant it was removed from the final model (Table 3). A final post estimation Wald test was conducted on the final model to provide a test of the estimated average yearly trend in both groups however this was not significant ( $p = 0.3972$ ).

Table 3

Unadjusted and adjusted Poisson regression models for the number of avoidable admissions calculated for each financial year of the study period (2005/06-2013/14) by Aboriginal status and explanatory factors (n = 19,025)

<b>Number of avoidable admissions</b>				
<b>Incidence rate ratios (IRR) (95% CI)</b>				
	<b>Unadjusted IRR</b>	<b>Adjusted IRR</b>	<b>Adjusted IRR &amp; restricted to &lt; 75 years</b>	<b>P-value</b>
<b>Aboriginal status</b>				< 0.0001
Non-Aboriginal	ref.	ref.	ref.	
Aboriginal	1.15 (1.12, 1.18)	1.16 (1.13, 1.20)	1.15 (1.11, 1.20)	
<b>Financial year</b>				0.3972*
2005-06	ref.	ref.	ref.	
2006-07	1.00 (0.94, 1.05)	1.00 (0.94, 1.05)	1.00 (0.93, 1.05)	
2007-08	0.96 (0.91, 1.01)	0.96 (0.91, 1.01)	0.94 (0.89, 1.00)	
2008-09	0.97 (0.92, 1.03)	0.97 (0.92, 1.02)	0.95 (0.90, 1.01)	
2009-10	0.96 (0.91, 1.01)	0.97 (0.92, 1.02)	0.94 (0.88, 0.99)	
2010-11	0.96 (0.91, 1.02)	0.96 (0.91, 1.01)	0.95 (0.89, 1.00)	
2011-12	0.98 (0.93, 1.03)	0.97 (0.92, 1.02)	0.96 (0.91, 1.02)	
2012-13	0.99 (0.94, 1.04)	0.98 (0.93, 1.03)	0.97 (0.92, 1.03)	
2013-14	0.98 (0.93, 1.04)	0.97 (0.93, 1.03)	0.96 (0.90, 1.01)	
<b>Gender</b>				
Male	-	ref.	ref.	
Female	-	1.00 (0.97, 1.02)	1.02 (0.99, 1.04)	0.270

\*Post estimation Wald test for financial year term.

<b>Number of avoidable admissions</b>				
<b>Incidence rate ratios (IRR) (95% CI)</b>				
<b>Age</b>	-	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)	< 0.0001
<b>Marital status</b>				
Married	-	ref.	ref.	
Single	-	1.06 (1.03, 1.10)	1.09 (1.05, 1.12)	< 0.0001
Widowed	-	1.04 (1.00, 1.08)	1.09 (1.04, 1.14)	0.001
Divorced/separated	-	1.09 (1.05, 1.13)	1.09 (1.04, 1.13)	< 0.0001
Not known	-	0.98 (0.89, 1.09)	0.99 (0.88, 1.11)	0.833
<b>IRSD</b>				
1st quintile – most disadvantaged	-	ref.	ref.	
2nd quintile	-	0.98 (0.95, 1.02)	0.99 (0.96, 1.03)	0.787
3rd quintile	-	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)	0.744
4th quintile	-	0.97 (0.93, 1.01)	0.99 (0.94, 1.04)	0.563
5th quintile – least disadvantaged	-	0.92 (0.87, 0.97)	0.88 (0.82, 0.95)	0.001
<b>ARIA</b>				
Highly Accessible	-	ref.	ref.	
Accessible	-	0.97 (0.94, 1.00)	0.96 (0.93, 0.99)	< 0.05
Moderately Accessible	-	0.98 (0.94, 1.02)	0.95 (0.91, 0.99)	< 0.05
Remote / Very Remote	-	1.02 (0.97, 1.08)	1.00 (0.95, 1.06)	0.924
*Post estimation Wald test for financial year term.				

<Insert Table 3 here>

When looking at whether or not an individual experienced three or more avoidable admissions each financial year, once adjusted for explanatory variables and restricted to ages 75 year or less, Aboriginal patients were almost two times more likely than non-Aboriginal patients to have frequent avoidable admissions per financial year (OR = 1.90; CI = 1.60, 2.26; Table 4). An interaction term between Aboriginal status and financial year demonstrated there were no significant differences between Aboriginal and non-Aboriginal people in yearly trends in the proportion of frequent avoidable admissions over the study period (Post estimation Wald test,  $p = 0.8599$ ). As this interaction was not significant, it was removed from the final model (Table 4). There was also no statistically significant average yearly trend in both groups (Post estimation Wald test,  $p = 0.3972$ ).

Table 4

Logistic regression model for three or more compared with one to two avoidable admissions: for each financial year of the study period (2005/06-2013/14) by Aboriginal status and explanatory factors (n = 19,025)

<b>≥ 3 avoidable admissions compared to 1 to 2 per financial year</b>				
<b>Odds ratios (OR) (95% CI)</b>				
	<b>Unadjusted OR</b>	<b>Adjusted OR</b>	<b>Adjusted OR &amp; restricted to &lt; 75 years</b>	<b>P-value</b>
<b>Aboriginal status</b>				<b>&lt; 0.0001</b>
Non-Aboriginal	ref.	ref.	ref.	
Aboriginal	1.79 (1.58, 2.03)	1.97 (1.71, 2.27)	1.90 (1.60, 2.26)	
<b>Financial year</b>				<b>0.6760*</b>
2005-06	ref.	ref.	ref.	
2006-07	0.93 (0.75, 1.16)	0.94 (0.75, 1.17)	0.91 (0.71, 1.16)	
2007-08	0.89 (0.71, 1.10)	0.88 (0.71, 1.10)	0.84 (0.66, 1.07)	
2008-09	0.86 (0.69, 1.08)	0.85 (0.68, 1.06)	0.78 (0.61, 0.99)	
2009-10	0.96 (0.77, 1.18)	0.93 (0.75, 1.16)	0.88 (0.69, 1.11)	
2010-11	0.94 (0.76, 1.17)	0.91 (0.73, 1.13)	0.92 (0.72, 1.17)	
2011-12	0.97 (0.79, 1.20)	0.93 (0.76, 1.15)	0.93 (0.74, 1.17)	
2012-13	0.90 (0.73, 1.11)	0.86 (0.69, 1.07)	0.85 (0.67, 1.08)	
2013-14	0.99 (0.81, 1.23)	0.96 (0.78, 1.18)	0.94 (0.74, 1.18)	
<b>Gender</b>				
Male	-	ref.	ref.	
Female	-	0.96 (0.86, 1.06)	1.01 (0.90, 1.13)	<b>0.864</b>

\* Post estimation Wald test for financial year term.

<b>≥ 3 avoidable admissions compared to 1 to 2 per financial year</b>				
<b>Odds ratios (OR) (95% CI)</b>				
<b>Age</b>	-	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	< 0.0001
<b>Marital status</b>				
Married	-	ref.	ref.	
Single	-	1.27 (1.11, 1.45)	1.37 (1.19, 1.59)	< 0.0001
Widowed	-	1.12 (0.96, 1.30)	1.31 (1.09, 1.58)	0.004
Divorced/separated	-	1.33 (1.14, 1.54)	1.34 (1.14, 1.57)	< 0.0001
Not known	-	0.92 (0.59, 1.45)	0.90 (0.54, 1.50)	0.694
<b>IRSD</b>				
1st quintile – most disadvantaged	-	ref.	ref.	
2nd quintile	-	0.86 (0.75, 0.99)	0.89 (0.76, 1.04)	0.146
3rd quintile	-	1.01 (0.86, 1.18)	1.00 (0.84, 1.20)	0.970
4th quintile	-	0.91 (0.76, 1.10)	1.00 (0.82, 1.23)	0.979
5th quintile – least disadvantaged	-	0.80 (0.63, 1.03)	0.69 (0.50, 0.95)	< 0.05
<b>ARIA</b>				
Highly Accessible	-	ref.	ref.	
Accessible	-	0.89 (0.78, 1.01)	0.85 (0.73, 0.98)	< 0.05
Moderately Accessible	-	0.98 (0.82, 1.16)	0.89 (0.74, 1.08)	0.245
Remote / Very Remote	-	1.11 (0.90, 1.38)	1.07 (0.85, 1.35)	0.549
* Post estimation Wald test for financial year term.				

<insert Table 4 here>

# Sensitivity Analysis

A sensitivity analysis was conducted to examine any potential differences in results when avoidable admissions ending in death were excluded. The regression analyses results were largely similar.

## Discussion

This study has demonstrated that Aboriginal people in NSW are significantly more likely to experience frequent avoidable admissions for ambulatory care sensitive chronic conditions compared with non-Aboriginal people. Aboriginal patients were 15% more likely to have a higher number of avoidable admissions for each financial year over the study period and were almost two times as likely to experience three or more avoidable admissions for each financial year compared to non-Aboriginal people. These findings remained significant after being adjusted for sociodemographic variables.

In our study the rates of both the number of avoidable admissions and whether or not an individual experienced three or more avoidable admissions per financial year remained consistently higher than non-Aboriginal people over the nine-year study period however there were no significant differences in yearly trends between Aboriginal and non-Aboriginal people. This finding demonstrates that Aboriginal people with chronic conditions are at a consistently higher risk of experiencing frequent avoidable admissions compared with non-Aboriginal people. Despite the “Closing the Gap” government strategy to reduce disadvantage among Aboriginal people in health, education and employment being in place since 2008,[24] there is no evidence of the gap being closed in the area of frequent avoidable admissions.

Our findings show that the heightened risk of frequent avoidable admissions is relevant to a small proportion of those Aboriginal people experiencing avoidable admissions. Over the study period an average of eleven percent of Aboriginal people experienced three or more avoidable admissions compared to just six percent in non-Aboriginal people. This is consistent with other research in the area of frequent admissions which reiterates the fact that a small proportion of patients account for a disproportionate share of avoidable admissions.[9, 15]

Research in the area of frequent avoidable admissions commonly aims to develop risk profiles or risk prediction tools to help identify those patients most at risk.[7, 9, 15] Our study showed that Aboriginal people experiencing avoidable admissions were more likely to be female, younger, single, have diabetes complications, asthma and COPD, live in moderately accessible to very remote locations, and to be more disadvantaged compared with non-Aboriginal people. Further research in identifying a risk profile for this vulnerable group of people would be helpful in creating appropriate community medical and prevention care.

The high risk of frequent avoidable admissions for Aboriginal people in part reflects the higher rate of chronic conditions in the Aboriginal population which accounts for most of the gap in life expectancy compared with non-Aboriginal people.[4] However it also highlights the health inequities and barriers that remain for Aboriginal people in terms of access to community health services. Cultural and locational

factors can impede access to appropriate primary and community health care services for Aboriginal people.[25] National survey data shows that Aboriginal people report difficulties in accessing health services and experience discrimination and services not being culturally appropriate.[26] As our findings demonstrated, compared to non-Aboriginal people, Aboriginal people with avoidable admissions were more likely to live remotely. Aboriginal people who live in remote areas can face practical, logistical and financial barriers which impact on the timeliness and effectiveness of health care.[27] For some Aboriginal people there are also high rates of homelessness, food insecurity, lack of transport, complex comorbidities and alcohol misuse.[16, 28] These underlying risk factors and consequences of social disadvantage have enduring effects and may contribute significantly to the disproportionate burden of frequent avoidable admissions among Aboriginal people.

Our study highlights the need to strengthen services that intervene before a patient needs to be admitted to hospital. Effective management of chronic disease in the primary care setting can delay the progression of disease, improve quality of life, increase life expectancy, and decrease the need to be admitted to hospital.[2, 29] However there is little intervention research in the area of frequent avoidable admissions for Aboriginal people with chronic conditions. A Northern Territory cohort study of a community-led case management program using a culturally competent framework to support frequent attenders aimed to address causes of recurrent emergency department presentations among Aboriginal people with complex social and medical backgrounds. The program was able to significantly improve engagement with primary care and reduce emergency department presentations but not frequent hospital admissions.[16] A retrospective analysis of primary care and inpatient records for Aboriginal patients with diabetes, also in the Northern Territory, found that a timely diabetes care plan was associated with better short-term blood glucose control and fewer diabetes-related admissions.[30] Although such studies provide promising results for reducing frequent avoidable admissions in Aboriginal people, there is still a need for rigorous, well-evaluated and culturally-appropriate interventions to provide robust evidence of effective strategies to help reduce frequent avoidable admissions.

Interestingly, our study found that Aboriginal people in this study had a significantly shorter average length of stay compared with non-Aboriginal people. As discussed in our previous paper examining unplanned readmissions in this same cohort,[31] this finding may indicate that Aboriginal patients with chronic conditions in NSW are not receiving adequate health care or are at higher risk of discharge against medical advice resulting in poorer health outcomes and increased risk of readmission or frequent avoidable admissions.

### *Limitations*

There are limitations to this study. Firstly, it is important to keep in mind that not all avoidable admissions may be avoidable. While many admissions could have been prevented through effective chronic disease management in the primary care setting, other admissions may reflect necessary admissions for seriously ill patients.[32] Secondly, national hospital records are likely to under-report Aboriginal status

and it is likely that the true numbers of avoidable admissions and their frequency among Aboriginal people are higher than reported in this study.[33]

## Conclusion

Over the nine years from 2005 to 2014 in NSW, Aboriginal people were significantly more likely to experience frequent avoidable admissions compared to non-Aboriginal people. This disproportionate risk remained consistent over the study period. The higher rates of frequent avoidable admissions reflect the higher rate of chronic conditions among Aboriginal people but also the need for further intervention research to establish evidence for effective and culturally appropriate programs which can successfully reduce frequent avoidable admissions among this group.

**Endnotes** <sup>1</sup>The importance of using correct, respectful and appropriate terminology for Aboriginal and Torres Strait Islander people is acknowledged. In keeping with NSW Health recommendations and acknowledging that Aboriginal people are the original inhabitants of NSW, the term Aboriginal people will be used (NSW Health “Communicating positively: A guide to appropriate Aboriginal terminology”, NSW Department of Health 2004).

## Abbreviations

ABS

Australian Bureau of Statistics; ACS:Ambulatory care sensitive; APDC:NSW Admitted Patient Data Collection; ARIA:Accessibility/Remoteness Index of Australia; CCI:Charlson Co-morbidity Index; CHF:Congestive heart failure; CI:confidence interval; COPD:Chronic obstructive pulmonary disease; IRR:Incidence rate ratio; IRSD:Index of Relative Socio-economic Disadvantage; NSW:New South Wales; OR:Odds ratio; RBDM:NSW Registrar of Births, Deaths and Marriages

## Declarations

*Ethics approval and consent to participate*

The study was approved by the NSW Population & Health Services Research Ethics Committee (HREC/15/CIPHS/18) and the NSW Aboriginal Health and Medical Research Council Ethics Committee (1090/15). The Ethics Committees granted a waiver of the usual requirement for the consent of the individual to the use of their health information in a research project, in line with the State Privacy Commissioner’s Guidelines for Research and the Health Records and Information Privacy Act 2002 (NSW). The Centre for Health Record Linkage preserve privacy and maintain robust data governance. As researchers are only able to access de-identified linked data, the Centre for Health Record Linkage enable ethically approved research in the public interest to be carried out without consent.

*Consent for publication*

Not applicable.

### *Availability of data and materials*

The data that support the findings of this study (The Centre for Health Record Linkage linked NSW government administrative datasets) are available from NSW Health but restrictions apply to the availability of these data and so are not publicly available. Access to the data is available by application to the data custodians, NSW Health.

### *Competing interests*

The authors declare that they have no competing interests

### *Funding*

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### *Authors' contributions*

AJ, CO and MC contributed to the design of the study. AJ drafted the manuscript. AJ and CO conducted the analysis, with advice from JA, and TE prepared the datasets. JB, CO, MC, ST, TE, R S-F and SE provided critical review of the manuscript. All authors contributed to the interpretation of findings, and have read and approved the final manuscript.

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## Figures

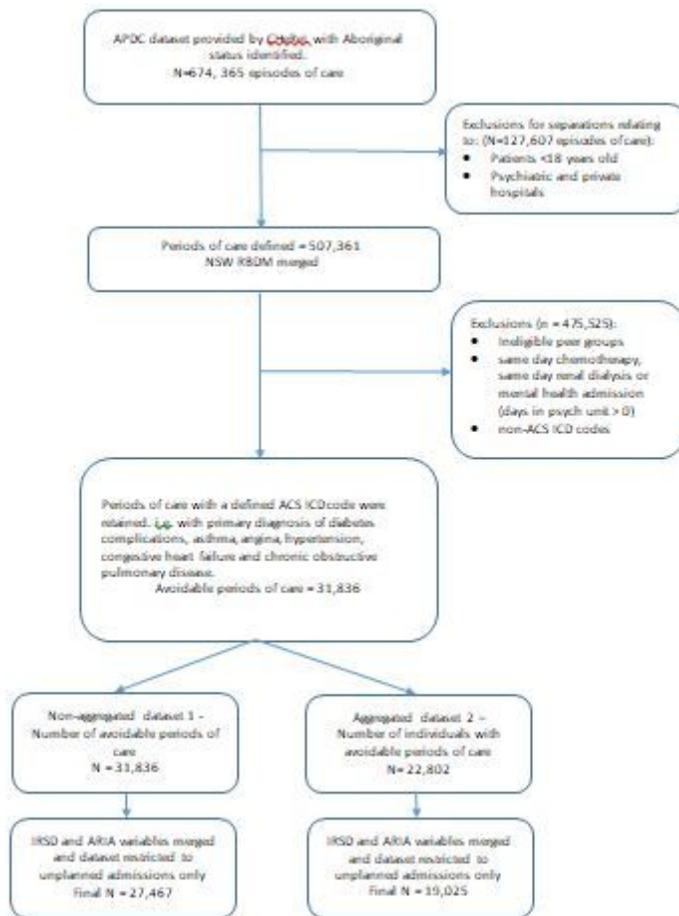


Figure 1

Flow diagram of dataset generation

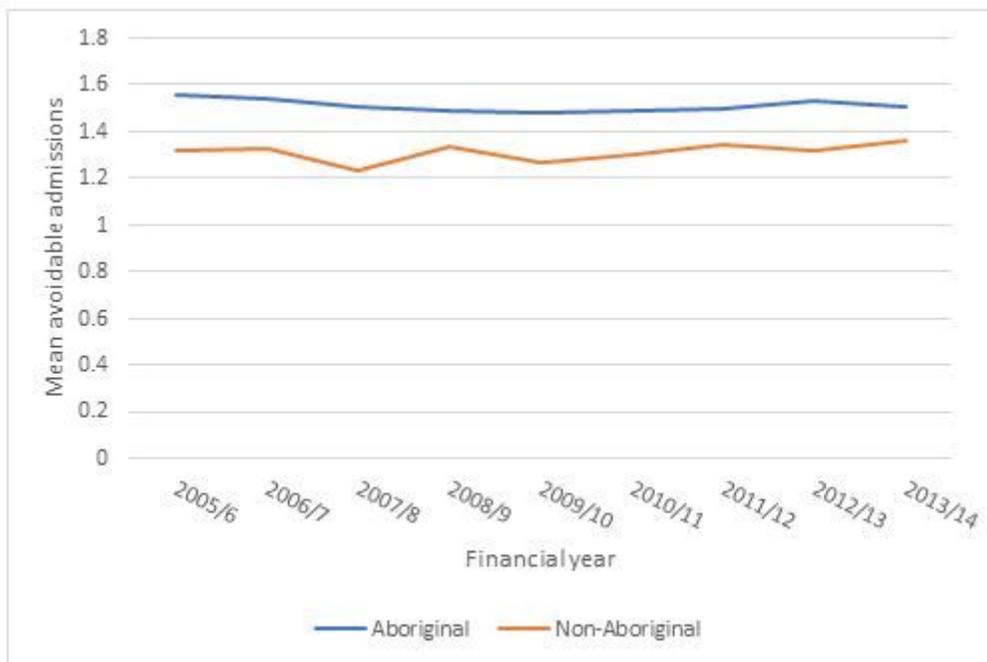


Figure 2

Mean number of avoidable admissions by Aboriginal status and financial year (n= 19,025)

## Supplementary Files

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