Received: 28 February 2022 | Revised: 20 July 2022 | Accepted: 1 August 2022

DOI: 10.1111/dar.13529

ORIGINAL PAPER

Drug and Alcohol REVIEW APSAD WILEY

Age at first alcohol-related hospital separation or emergency department presentation and rate of re-admission: A retrospective data linkage cohort of young Australians

Wing S. Yuen[1] | Janni Leung[2] | Nicola Man[1] | Vivian Chiu[2] | Natasa Gisev[1] | Michael Livingston[3,4] | Louisa Degenhardt[1] | Michael Farrell[1] | Sallie-Anne Pearson[5] | Timothy Dobbins[6] | Adrian Dunlop[7] | Richard P. Mattick[1] | Amy Peacock[1,8]

[1]National Drug and Alcohol Research Centre, UNSW Sydney, Sydney, Australia

[2]National Centre for Youth Substance Use Research, The University of Queensland, Brisbane, Australia

[3]National Drug Research Institute, Curtin University, Melbourne, Australia

[4]Centre for Alcohol Policy Research, La Trobe University, Melbourne, Australia

[5]Centre for Big Data Research in Health, UNSW Sydney, Sydney, Australia

[6]School of Population Health, UNSW Sydney, Sydney, Australia

[7]School of Medicine and Public Health, University of Newcastle, Newcastle, Australia

[8]School of Psychological Sciences, University of Tasmania, Hobart, Australia

Correspondence
Wing S. Yuen, National Drug and Alcohol Research Centre, Faculty of Medicine, UNSW Sydney, Sydney, NSW 2052, Australia.
Email: w.yuen@unsw.edu.au

Funding information
Department of Health, Australian Government; National Drug and Alcohol Research Centre; National Health and Medical Research Council, Grant/Award Numbers: 1041472, 1109366, 1135991,

Abstract

Introduction: Alcohol is a leading risk factor for death and disease in young people. We compare age-specific characteristics of young people who experience their first ('index') alcohol-related hospitalisation or emergency department (ED) presentation, and whether age at index predicts 12-month rates of readmission.

Methods: We used a retrospective linked-data cohort of 10,300 people aged 12–20 years with an index alcohol-related hospital and/or ED record in New South Wales, Australia from 2005 to 2013. Age group (early adolescent [12–14 years], late adolescent [15–17 years], young adult [18–20 years]) and diagnosis fields were used in logistic regression analyses and to calculate incidence rates with adjustment for year of index event, sex, socioeconomic disadvantage and residence remoteness.

Results: People who experienced their index event in early adolescence (adjusted relative risk ratio [ARRR] 0.45 [95% confidence interval 0.39, 0.52]) or late adolescence (ARRR 0.82 [0.74, 0.90]) were less likely to be male compared to young adults. Early adolescents (ARRR 0.60 [0.51, 0.70]) and late adolescents (ARRR 0.84 [0.76, 0.93]) were less likely to have a hospitalisation index event. Early adolescents (adjusted incidence rate ratio 1.40 [1.15, 1.71]) and late adolescents (adjusted incidence rate ratio 1.16 [1.01, 1.34]) were more likely than young adults to have a subsequent 12-month non-poisoning injury ED presentation.

Discussion and Conclusions: We identified preventable hospital events in young people who have previously experienced an alcohol-related ED presentation or hospitalisation, with age-specific characteristics and outcomes that can be used to inform future health policy and service planning.

1174630; National Institute on Drug Abuse, Grant/Award Number: R01DA1104470; University of New South Wales; University of Queensland

KEYWORDS
alcohol, emergency department, hospitalisation, record linkage, young people

Key Points

- People who experience an alcohol-related event for the first time at a younger age are more likely to present to an emergency department rather than be admitted to hospital.
- People who experience an alcohol-related event for the first time at a younger age are more likely to be female compared to people who experience an alcohol-related event for the first time in early adulthood.
- Experiencing an alcohol-related event for the first time at a younger age increases the risk of injury-related readmissions in the subsequent 12 months.

1 | INTRODUCTION

Alcohol use has been the leading global risk factor for death and disease since 1990 in adolescents and young adults (hereafter 'young people', aged between 12 and 20 years) [1]. Indeed, nearly 10% of deaths in young people worldwide in 2016 were attributable to alcohol consumption [2]. In Australia, people aged 18–24 years are more likely to exceed the single-occasion risk guideline (four standard drinks) than any other age group [3].

Across the population, people typically initiate alcohol use in mid-adolescence [4] and subsequently escalate alcohol use until their mid-20s [5]. However, cohort studies show that development of alcohol use usually varies among young people [6–10]. While some initiate alcohol use in early adolescence (i.e., before age 15 years), others abstain until adulthood (age 18 years or older) [6, 7, 9]. Once initiated, some young people rapidly increase the frequency and quantity of their drinking, whereas others remain infrequent and/or moderate drinkers [6–9]. Longitudinal cohort studies show that certain factors in early adolescence, such as peer alcohol use, can predict alcohol development patterns [6, 10]. Importantly, patterns involving earlier initiation and/or rapid escalation are linked to future adverse health outcomes such as alcohol-use disorders [6, 10, 11]. It is unclear, however, whether the timing of the experience of alcohol-related harm can be similarly predicted and whether this timing confers differential risk of further harm.

While young people with alcohol use problems such as alcohol dependence rarely seek treatment [12, 13], there has been an increase in young people accessing health services for acute (e.g., injuries) and/or chronic health problems (e.g., liver disease) due to problematic alcohol use [14–16]. Examining young people at their first-ever presentation to inpatient and emergency department (ED) services with an alcohol-related problem (hereafter 'index event') can inform targeted interventions to reduce re-presentation and longer-term costs to the health of these people. Indeed, adults hospitalised for alcohol-related problems in Denmark were far more likely than the general population to be readmitted for a wide range of diagnoses (e.g., alcohol poisoning, liver disease, stroke, injuries) and to also die from various causes of death (e.g., liver cancer, cardiovascular disease, suicide and accidental injury) [17]. However, it is currently unknown whether people who experience their first alcohol-related health service event (hospitalisation or ED presentation) earlier in adolescence have different profiles and outcomes to people who experience their first event later in adolescence or in early adulthood.

As such, the aim of this study was to identify young people at their index alcohol-related hospital separation or ED presentation and examine differences by age group (early adolescent [12–14 years], late adolescent [15–17 years], young adult [18–20 years]). Specifically, this study examines: (i) sociodemographic and clinical characteristics by age group at index event; and (ii) age group at index event as a predictor of rates of subsequent health service utilisation (including alcohol-related and other substance-related utilisation) within 12 months of index event separation.

2 | METHODS

2.1 | Participants

We used data from a subset of people from the existing Data-Linkage Alcohol Cohort Study [18]. This set of linked administrative data consists of hospital and ED records from people in New South Wales (NSW), Australia, who were admitted to hospital or presented to an ED with evidence of an alcohol-related diagnosis between 1 January 2005 and 31 December 2014. An alcohol-related diagnosis was defined as one or more of the conditions in Table 1, presented as International Classification of Diseases Version 10 Australian

Drug and Alcohol REVIEW APSAD WILEY

TABLE 1 List of alcohol-related diagnoses

Category	ICD-10 AM code	Condition
Alcohol poisoning	R78.0	Finding of alcohol in blood
	T51	Toxic effect of alcohol
	X45	Accidental poisoning by and exposure to alcohol
	X65	Intentional self-poisoning by and exposure to alcohol
	Y15	Poisoning by and exposure to alcohol, undetermined intent
	Y90	Evidence of alcohol involvement determined by blood alcohol level
	Y91	Evidence of alcohol involvement determined by level of intoxication
Mental/behavioural condition	F10.0	Acute intoxication
	F10.1	Harmful use of alcohol
	F10.2	Alcohol dependence
	F10.3	Alcohol withdrawal
	F10.4-F10.9	Other alcohol-induced mental conditions
Other physical condition	E24.4	Alcohol-induced pseudo-Cushing's syndrome
	E51.2	Wernicke encephalopathy
	G31.2	Degeneration of nervous system due to alcohol
	G62.1	Alcoholic polyneuropathy
	G72.1	Alcoholic myopathy
	I42.6	Alcoholic cardiomyopathy
	K29.2	Alcoholic gastritis
	K70.0-K70.4, K70.9	Alcohol-induced liver diseases
	K85.2, K86.0	Alcohol-induced pancreatitis

Note: Equivalent codes for International Classification of Diseases 9th Version Clinical Modification and Systematised Nomenclature of Medicine Clinical Terms Australian version are shown in Data S1.
Abbreviation: ICD-10-AM, International Classification of Diseases Version 10 Australian Modification.

Modification (ICD-10-AM) codes. ICD 9th Version Clinical Modification (ICD-9-CM) and Systematised Nomenclature of Medicine Clinical Terms Australian version (SNOMED CT-AU) equivalent codes are shown in Appendix S1 in Data S1, Supporting Information. For hospital separations, a principal diagnosis and up to 50 additional diagnoses could be provided. For ED presentations, only the principal diagnosis field was provided. Data linkage was completed by the Centre for Health Record Linkage using ChoiceMaker, a probabilistic record linkage software [19]. Ethics approval was provided by the NSW Population and Health Services Research Ethics Committee [18].

We restricted the Data-Linkage Alcohol Cohort Study cohort to people born between 1992 and 2001 with their first alcohol-related hospital separation or ED presentation record between 2005 and 2013. We considered this record as their index event. If a person had both an ED presentation and hospital separation record on the same day, the record with an alcohol-related diagnosis was used as their index event. If both records had an alcohol flag, the ED presentation was used. This ensured that the sample consisted of people aged between 12 and 20 years that have not had any prior alcohol-related hospital separations or ED presentations between age 12 years and the age of their index event (see Appendix S2 in Data S1, for the number of people entering the cohort each year by age at cohort entry). We chose the age of 12 years for the lower bound for this subset as the mean age of initiation of alcohol in Australia was 14.7 years in 2001 and has since steadily risen [20], so it is unlikely that people below age 12 years would have experienced alcohol-related harm. Studies in hospital and ED settings in the United Kingdom and Australia have also reported that adolescents who present with alcohol intoxication tend to be aged 12 years or older [21, 22]. This method of truncating the cohort also ensures that there is at least one person-year of follow-up for each person during the period of 2005 to 2013. A flowchart of the cohort formation can be found in Appendix S3 in Data S1.

2.2 | Data sources

2.2.1 | Hospital data

The Admitted Patient Data Collection (APDC) is administered by the NSW Health Department and contains records of all hospital separations provided by public hospitals, public psychiatric hospitals, public multi-purpose services (e.g., integrated health and aged care services), private hospitals and private day procedure centres in NSW. Primary and secondary diagnoses were coded using the ICD-10-AM codeset.

2.2.2 | Emergency department data

The Emergency Department Data Collection (EDDC) is administered by the NSW Health Department and contains records of all patient presentations to participating public hospital EDs in NSW. The number of participating EDs increased over time from 46 (30%) in 1996 to 90 (60%) in 2010. Diagnoses were coded using the ICD-9-CM, ICD-10-AM and SNOMED-CT-AU codesets.

2.2.3 | Mortality data

The NSW Registry of Births, Deaths and Marriages and the Australian Coordinating Registry Cause of Death Unit Record File are two data sets containing mortality information for deaths that were recorded in NSW. The former provides information regarding date of birth and fact of death, whereas the latter includes additional information such as cause of death. In this study, these data were used solely for the purposes of adjusting for mortality when deriving person years for our 12-month follow-up analysis for Aim 2.

2.3 | Measures

2.3.1 | Age at index event

Age at index event was calculated from the date of birth and date of separation (APDC) or presentation (EDDC) variables. This was then recoded into 3-year age groups (early adolescent [12–14 years; prior to median age of alcohol use onset] [4, 20], late adolescent [15–17 years; post-median age of alcohol use onset], young adult [18–20 years; age of legal alcohol purchase and consumption at licenced venue in Australia, which commences from 18 years onwards]).

2.3.2 | Sociodemographic characteristics

To examine sociodemographic characteristics, we used variables from the APDC and EDDC data sets including sex (male, female), remoteness area of usual residence (major city, inner regional, outer regional, remote, very remote; collapsed into two categories: major city, regional/remote) [23] and Index of Relative Socioeconomic Disadvantage which ranks geographical area of usual residence by relative disadvantage based on the Australian Bureau of Statistics Census [24] in quintiles.

2.3.3 | Clinical characteristics

To examine clinical characteristics at the index event, we grouped diagnosis codes into the categories of 'alcohol poisoning', 'mental/behavioural condition' and 'other physical condition' based on ICD-10-AM labelling. We created binary variables that flagged any records for these categories across all diagnosis fields (see Table 1 for list of codes). As the APDC data set has multiple diagnosis fields, people may have more than one type of alcohol-related diagnosis.

2.3.4 | Subsequent hospital and ED events

To examine 12-month utilisation of health services after the index event, we calculated person-years by adding 365 days to the date of separation (APDC) or date of presentation (EDDC). People who died within 12 months of their index event were censored using the date of death variable from the NSW Registry of Births, Deaths and Marriages and Australian Coordinating Registry Cause of Death Unit Record File datasets. Using APDC and EDDC diagnosis fields, subsequent hospital separations and ED presentations were broadly classified as: (i) any hospital separation or ED presentation; (ii) ED presentation; and (iii) hospital separation. These were further classified into alcohol-specific, other substance-specific, non-substance mental disorder and other accidental injury for hospital separations and ED presentations (see Appendix S4 in Data S1, for list of codes). SNOMED-CT-AU codes from the EDDC were mapped to ICD-10-AM equivalent codes using the Commonwealth Scientific and Industrial Research Organisation snoMAP Starter tool and the National Library of Medicine Unified Medical Language System mapping project. Of the 7583 SNOMED-CT-AU codes we attempted to map to ICD-10-AM in this cohort, 287 (3.8%) were unable to be matched.

Drug and Alcohol REVIEW APSAD WILEY

2.4 | Statistical analysis

We conducted all analyses in SAS v9.4 (SAS Institute Inc. Cary, NC, USA) using complete-case data. These analyses were not pre-registered and should thus be considered exploratory. Reporting is consistent with the RECORD guidelines (Appendix S5 in Data S1).

2.4.1 | Association between sociodemographic and clinical characteristics and age at index

We used multinomial logistic regression models to determine whether the sociodemographic and clinical characteristics described above were associated with age group at index event. To account for potential year effects, we adjusted for year of index event. Results are presented as adjusted relative risk ratios (ARRR) with 95% confidence intervals.

2.4.2 | Subsequent hospital and ED events by age at index

We calculated rates per person-years (PY) and incidence rates for subsequent 12-month hospital and ED events in the cohort from the date of index separation, disaggregated by age group at index event. Incidence rates per 100 PY in the cohort were calculated using Poisson or negative binomial regression models (depending on the estimated over-dispersion of the variable) to examine subsequent hospital and ED events. Comparisons of the cohort incidence rates are presented as adjusted incidence rate ratios (AIRR) with 95% confidence intervals. Models were adjusted for sex, year of index event, socioeconomic status and remoteness area of usual residence. SNOMED-CT-AU codes from the EDDC that were unable to be mapped to ICD-10-AM codes were retained for 'any' episode analyses and dropped for cause-specific analyses.

3 | RESULTS

Our study included 10,300 young people. Table 2 shows the demographic characteristics of the overall cohort and by age group. The largest age group was the late adolescent group, comprising 48.4% (n = 4984) of the cohort, followed by the young adult (35.5%; n = 3656) and early adolescent (16.1%; n = 1660) groups. There were marginally more males than females overall (51.5% male; n = 5303). Half of the cohort were in the two most disadvantaged socio-economic quintiles (52.1%; n = 5366) and the majority resided in major cities (63.0%; n = 6490). Index records predominantly consisted of ED presentations (64.0%; n = 6587), with acute intoxication being the most common reason for hospital separations and ED presentations (66.6%; n = 6856).

3.1 | Association between sociodemographic and clinical characteristics and age at index

For all regression models (Table 2), we chose the young adult group as the reference as it is the age group that has the highest prevalence of alcohol-related harms in the population. After adjusting for year of index event, relative to females, males were less likely to be in the early adolescent group (ARRR 0.45 [0.39, 0.52]) and late adolescent group (ARRR 0.82 [0.74, 0.90]) compared to young adult group. With the most disadvantaged socio-economic quintile as the reference, adjusted analyses showed that people in the least disadvantaged quintile were more likely to be in the late adolescent group compared to the young adult group (ARRR 1.29 [1.12, 1.49]). There was a lack of clear evidence of an association between the early adolescent group and the young adult group with respect to socioeconomic disadvantage. Likewise, associations between remoteness area of usual residence and index age group were inconclusive.

Adjusted analyses showed that people whose index event was a hospital separation (vs. an ED presentation) were less likely to be in the early adolescent group compared to the young adult group (ARRR 0.60 [0.51, 0.70]). Adjusted analyses also showed that people whose index event was a hospital separation were less likely to be in the late adolescent group compared to the young adult group (ARRR 0.84 [0.76, 0.93]). People whose index event included a 'mental/behavioural condition' diagnosis code were more likely to be in the early adolescent group (ARRR 1.59 [1.19, 2.13]) and the late adolescent group (ARRR 1.45 [1.20, 1.75]) compared to the young adult group. People whose index event included an 'other physical condition' diagnosis code were less likely to be in the early adolescent group (ARRR 0.21 [0.10, 0.41]) and the late adolescent group (ARRR 0.34 [0.24, 0.49]) compared to the young adult group. Associations between the presence of the 'alcohol poisoning' diagnoses and index age group were inconclusive for both the unadjusted and adjusted models.

TABLE 2 Socio-demographic and clinical characteristics at index event for people aged 12 to 20 years with a hospital contact for an alcohol-related problem in New South Wales, Australia from 2005 to 2013

	Total, $n = 10{,}300$ (%)	A. Early adolescent (12–14 years), $n = 1660$ (%)	B. Late adolescent (15–17 years), $n = 4984$ (%)	C. Young adult (18–20 years), $n = 3656$ (%)	A versus C (ref.), RRR (95% CI)	A versus C (ref.), Adjusted RRR (95% CI)	B versus C (ref.), RRR (95% CI)	B versus C (ref.), Adjusted RRR (95% CI)
Sex								
Male	5301 (51.5)	646 (38.9)	2594 (52.1)	2061 (56.4)	**0.49 (0.44, 0.55)**	**0.45 (0.39, 0.52)**	**0.84 (0.77, 0.91)**	**0.82 (0.74, 0.90)**
Female	4996 (48.5)	1014 (61.1)	2389 (47.9)	1593 (43.6)	Ref.	Ref.	Ref.	Ref.
Socio-economic disadvantage quintile								
1 (Most disadvantaged)	2788 (27.1)	468 (28.2)	1333 (26.8)	987 (27.0)	Ref.	Ref.	Ref.	Ref.
2	2578 (25.0)	428 (25.8)	1219 (24.5)	931 (25.5)	0.97 (0.83, 1.14)	1.03 (0.85, 1.25)	0.97 (0.86, 1.09)	0.99 (0.87, 1.14)
3	1681 (16.3)	252 (15.2)	790 (15.9)	639 (17.5)	0.83 (0.69, 1.00)	0.85 (0.68, 1.06)	0.92 (0.80, 1.05)	0.92 (0.79, 1.07)
4	1176 (11.4)	184 (11.1)	569 (11.4)	423 (11.6)	0.92 (0.75, 1.13)	1.00 (0.78, 1.28)	1.00 (0.86, 1.16)	1.02 (0.86, 1.22)
5 (least disadvantaged)	2074 (20.1)	327 (19.7)	1072 (21.5)	675 (18.5)	1.02 (0.86, 1.21)	1.16 (0.94, 1.43)	**1.18 (1.04, 1.33)**	**1.29 (1.12, 1.49)**
Missing	[a]	[a]	[a]	[a]				
Remoteness area of usual residence								
Major city	6490 (63.0)	1031 (62.1)	3176 (63.7)	2283 (62.5)	0.99 (0.87, 1.11)	1.02 (0.89, 1.18)	1.06 (0.97, 1.15)	1.08 (0.98, 1.20)
Regional/remote	3810 (37.0)	629 (37.9)	1808 (36.3)	1373 (37.6)	Ref.	Ref.	Ref.	Ref.
Service accessed								
Hospital separation	3713 (36.0)	487 (29.3)	1810 (36.3)	1416 (38.8)	**0.66 (0.58, 0.74)**	**0.60 (0.51, 0.70)**	**0.90 (0.83, 0.99)**	**0.84 (0.76, 0.93)**
Emergency department	6587 (64.0)	1173 (70.7)	3174 (63.7)	2240 (61.3)	Ref.	Ref.	Ref.	Ref.
Diagnosis type[b]								
Alcohol poisoning	612 (5.9%)	94 (5.7%)	282 (5.7%)	236 (6.5%)	0.87 (0.68, 1.11)	0.83 (0.61, 1.13)	0.87 (0.73, 1.04)	0.90 (0.74, 1.11)
Mental/behavioural condition	9568 (92.9%)	1561 (94.0%)	4674 (93.8%)	3333 (91.2%)	**1.53 (1.21, 1.93)**	**1.59 (1.19, 2.13)**	**1.46 (1.24, 1.72)**	**1.45 (1.20, 1.75)**
Other physical condition	225 (2.2%)	11 (0.7%)	66 (1.3%)	148 (4.1%)	**0.16 (0.09, 0.29)**	**0.21 (0.10, 0.41)**	**0.32 (0.24, 0.43)**	**0.34 (0.24, 0.49)**

Note: Bolded statistics indicate $p < 0.05$. Percentages rounded to one decimal place. Adjusted correlate models adjust for year of index event.

Abbreviations: CI, confidence interval; RRR, relative risk ratio.

[a]Suppressed due to low cell size ($n < 10$).

[b]Coded as three separate binary variables as diagnosis types are not mutually exclusive, people in the Admitted Patient Data Collection may present with more than one alcohol-related diagnosis.

Drug and Alcohol REVIEW ASAD — WILEY

TABLE 3 Rates of subsequent 12-month emergency department presentations and hospital presentations per 100 person years by age group at index event

	A. Early-mid adolescent (12–14 years; PY = 1660)			B. Mid-late adolescent (15–17 years; PY = 4977.55)			C. Young adult (18–20 years; PY = 3646.02)			A versus C (ref)		B versus C (ref)	
	n people (events)	IR (95% CI)	Adjusted IR[a] (95% CI)	*n* people (events)	IR (95% CI)	Adjusted IR[a] (95% CI)	*n* people (events)	IR (95% CI)	Adjusted IR[a] (95% CI)	IRR (95% CI)	Adjusted IRR[a] (95% CI)	IRR (95% CI)	Adjusted IRR[a] (95% CI)
Any ED/hospital contact	957 (3064)	184.58 (170.63, 199.67)	179.40 (164.55, 195.60)	2739 (9128)	183.48 (175.33, 192.00)	180.51 (172.50, 188.89)	2059 (7245)	200.19 (189.91, 211.02)	194.09 (183.19, 205.64)	0.92 (0.84, 1.01)	0.92 (0.83, 1.03)	**0.92 (0.85, 0.98)**	0.93 (0.86, 1.00)
Any emergency department presentation	716 (2063)	124.28 (113.88, 135.62)	121.36 (110.30, 133.53)	2201 (5911)	118.84 (112.96, 125.02)	115.02 (109.35, 120.99)	1669 (4672)	128.89 (121.53, 136.69)	120.67 (113.16, 128.68)	0.96 (0.87, 1.07)	1.01 (0.89, 1.14)	0.92 (0.85, 1.00)	0.95 (0.88, 1.04)
Alcohol-specific ED presentation	82 (96)	5.78 (4.54, 7.36)	6.05 (4.62, 7.91)	175 (193)	3.88 (3.30, 4.56)	3.88 (3.30, 4.57)	146 (193)	5.29 (4.47, 6.26)	4.90 (4.05, 5.93)	1.09 (0.81, 1.47)	1.23 (0.86, 1.76)	**0.73 (0.58, 0.92)**	0.79 (0.61, 1.02)
Other substance-specific ED presentation	13 (14)	0.84 (0.50, 1.42)	1.16 (0.58, 2.32)	46 (50)	1.00 (0.76, 1.33)	0.93 (0.65, 1.34)	41 (90)	2.47 (2.01, 3.04)	1.16 (0.75, 1.78)	**0.34 (0.19, 0.60)**	1.00 (0.42, 2.38)	**0.41 (0.29, 0.57)**	0.80 (0.47, 1.38)
Non-substance mental disorder ED presentation	60 (109)	6.57 (4.94, 8.72)	6.68 (4.88, 9.15)	181 (250)	5.02 (4.22, 5.98)	4.74 (3.97, 5.66)	156 (252)	6.93 (5.73, 8.37)	5.75 (4.64, 7.11)	0.95 (0.67, 1.33)	1.16 (0.77, 1.75)	**0.72 (0.56, 0.94)**	0.83 (0.62, 1.09)
Other injuries of external causes ED presentation[b]	217 (319)	19.22 (16.67, 22.15)	20.56 (17.65, 23.96)	649 (905)	18.19 (16.73, 19.77)	17.07 (15.69, 18.58)	476 (631)	17.30 (15.67, 19.10)	14.67 (13.14, 16.38)	1.11 (0.93, 1.32)	**1.40 (1.15, 1.71)**	1.05 (0.92, 1.20)	**1.16 (1.01, 1.34)**
Any hospitalisation	594 (1001)	60.30 (54.65, 66.53)	57.52 (51.59, 64.14)	1663 (3217)	64.63 (61.11, 68.35)	63.97 (60.45, 67.69)	1243 (2573)	70.87 (66.45, 75.59)	71.81 (66.87, 77.13)	**0.85 (0.76, 0.96)**	**0.80 (0.70, 0.92)**	**0.91 (0.84, 0.99)**	**0.89 (0.81, 0.98)**
Alcohol-specific hospitalisation	376 (413)	24.88 (22.25, 27.82)	23.94 (21.11, 27.14)	862 (1024)	20.57 (19.19, 22.05)	20.38 (19.00, 21.86)	591 (777)	21.32 (19.69, 23.10)	21.79 (19.96, 23.80)	**1.17 (1.02, 1.34)**	1.10 (0.93, 1.30)	0.96 (0.87, 1.07)	0.94 (0.83, 1.05)
Other substance-specific hospitalisation	76 (108)	6.51 (4.93, 8.58)	7.01 (5.17, 9.52)	276 (462)	9.28 (8.00, 10.76)	9.21 (7.94, 10.69)	210 (426)	11.69 (9.90, 13.81)	10.87 (9.00, 13.13)	**0.56 (0.40, 0.77)**	**0.65 (0.44, 0.95)**	0.79 (0.63, 0.99)	0.85 (0.66, 1.08)
Non-substance mental disorder hospitalisation	134 (302)	18.19 (14.57, 22.72)	16.74 (13.04, 21.50)	431 (982)	19.74 (17.39, 22.41)	18.00 (15.86, 20.43)	318 (731)	20.15 (17.38, 23.37)	19.36 (16.47, 22.75)	0.90 (0.69, 1.18)	0.86 (0.63, 1.20)	0.98 (0.81, 1.19)	0.93 (0.75, 1.15)
Other injuries of external causes hospitalisation[b]	123 (174)	10.48 (8.73, 12.59)	10.52 (8.61, 12.86)	399 (498)	10.00 (8.99, 11.14)	9.73 (8.73, 10.85)	339 (447)	12.30 (10.94, 13.84)	11.49 (10.07, 13.12)	0.85 (0.69, 1.06)	0.92 (0.71, 1.19)	**0.81 (0.69, 0.95)**	0.85 (0.71, 1.01)

Note: Bolded statistics indicate $p < 0.05$.
Abbreviations: CI, confidence interval; ED, emergency department; IR, incidence rate; IRR, incidence rate ratio; PY, person years of observation.
[a]Estimated for a balanced population using least squares means in SAS adjusting for sex, year of index event, socioeconomic status and remoteness area of usual residence.
[b]Excludes overdose and poisoning.

3.2 | Subsequent hospital separations and ED presentations by age at index

Table 3 shows the number and rates per 100 PY of ED presentations and hospital separations across the cohort in the 12 months following cohort entry. In the early adolescent group, there were 2063 ED presentations and 1001 hospital separations across 1660.0 PY. These were accounted for by 716 (43.1% of age group) and 594 (35.8%) people, respectively. In the late adolescent group, there were 5911 ED presentations (n people = 2201, 44.2% of age group) and 3217 hospital separations (n people = 1663, 33.4%) across 4977.6 PY. In the young adult group, there were 4672 ED presentations (n people = 1669, 45.7%) and 2573 hospital separations (n people = 1243, 34.0%) across 3646.0 PY. Across all age groups, 403 people (3.9%) experienced at least one and 39 (0.4%) experienced at least two subsequent alcohol-related ED presentations. For alcohol-related hospitalisations, 1829 people (17.8%) experienced at least one and 192 (1.9%) experienced at least two subsequent hospital separations.

After adjusting for year of cohort entry, sex, socio-economic status, and remoteness of usual residence, analyses showed that people in the early adolescent group (AIRR 1.40 [1.15, 1.71]) and late adolescent group (AIRR 1.16 [1.01, 1.34]) had higher rates of non-poisoning injury ED presentations compared to the young adult group. The early adolescent group had lower rates of any hospital separation (AIRR 0.80 [0.70, 0.92]) and non-alcohol substance-related hospital separation (AIRR 0.65 [0.44, 0.95]) compared to the young adult group. Similarly, the late adolescent group had lower rates of any hospital separation compared to the young adult group (AIRR 0.89 [0.81, 0.98]).

4 | DISCUSSION

Our study used linked administrative data to examine the characteristics and 12-month readmission rates of a cohort of young people who presented to an ED or were hospitalised for an alcohol-related problem in NSW, Australia for the first time since age 12 years. Correlates of younger age at index event included: female sex, presenting to an ED (vs. hospital separation) and presenting with a mental/behavioural condition (e.g., acute intoxication). In the 12-months following index, non-poisoning injury ED presentation rates were higher among adolescents compared to young adults and overall rates of hospitalisation were slightly lower among adolescents compared to young adults.

Males were much more likely to be older at their first event, being 55% less likely to be in the early adolescent group and 18% less likely to be late adolescent group compared to the young adult group. This finding contrasts with existing reports of early adolescent alcohol consumption, where no sex differences in levels of alcohol use have been found in Australia, [6, 25] nor in other regions such as the United Kingdom [26]. A potential explanation could be that while females have similar rates of binge drinking to males in early adolescence, females tend to reach higher levels of intoxication compared to males when consuming the same amount of alcohol, and are thus more likely to experience alcohol problems requiring hospitalisation [27]. Indeed, the majority of alcohol-related diagnoses in our cohort were related to intoxication and our findings mirror that of a Dutch study [28] and a Welsh study [29] on adolescents admitted to hospital for alcohol problems, where people aged 16 and younger were less likely to be male, but older adolescents were more likely to be male. Importantly, qualitative studies have found that young people tend to be unaware that the effect of alcohol can depend on physical differences in body size and sex [30, 31]. Accordingly, strategies to reduce alcohol-related harms in young people should consider improving education messaging for adolescents and young adults to elucidate the role of physiological differences in how alcohol affects the body.

Late adolescents in our cohort were less likely to be disadvantaged than younger adults, but no differences were found between early-adolescents and young adults. A possible explanation for late adolescents being less likely to be disadvantaged than young adults is that there is an influx of young people at this age who: (i) are consuming alcohol for the first time, with most adolescents starting to use alcohol at the ages encompassed by our late-adolescent group (15–17 years) [4]; and (ii) are less disadvantaged and thus have more discretionary funds to experiment with alcohol. Overall, however, our cohort was skewed towards people who were more disadvantaged, with 52% of the cohort being in the lowest two quintiles. In addition, a higher proportion of our cohort resided outside of major cities (37%) compared to the general NSW population of the same age (25%) [32], which does not necessarily mean that our sample is not representative, but is likely explained by higher rates of alcohol use among young people residing in rural Australia [33]. This is consistent with ED [29] and linked cohort [34] studies that have found greater socio-economic disadvantage to be associated with greater alcohol-related harm, disproportionate in contrast to findings that less socio-economic disadvantage is associated with heavy episodic drinking [35]. The reasons for this discrepancy between consumption and harm are complex [36], and potential strategies to address this inequity include licencing changes that target the over-representation of

alcohol outlets in disadvantaged areas and interventions that target vulnerable populations [37].

Most of our cohort experienced their first alcohol-related event as an ED presentation rather than a hospital separation, with ED presentations being more likely in the adolescent groups compared to young adults. This suggests that people who experience their first alcohol-related event at a younger age are more likely to have an acute problem compared to people who are older. Much of our cohort received an acute intoxication diagnosis, with relatively few being diagnosed with alcohol poisoning or other physical conditions. Younger adolescents compared to young adults were 45%–59% more likely to be diagnosed with mental/behavioural conditions such as acute intoxication and were 66%–79% less likely to be diagnosed with other physical conditions such as alcoholic liver disease. This is expected as young adults tend to have had longer exposure to alcohol and therefore had the opportunity to develop conditions associated with chronic alcohol use.

In the 12 months following the index event, non-poisoning injury ED presentations were 40% higher in people who experienced their index event in early adolescence and 16% higher in late adolescence compared to young adulthood after controlling for other socio-demographic characteristics. Given the dose–response relationship between alcohol use and injury [38] and the under-detection of alcohol involvement in injury ED presentations [39], it is likely that a substantial number of these injury ED presentations in our cohort were related to alcohol use. Indeed, there is evidence from NSW that the introduction of alcohol licencing regulations significantly reduced the rate of serious injury in the same area by 24.8% [40]. Thus, addressing alcohol-related issues in young people, especially adolescents, can have the added benefit of reducing overall rates of injury. Indeed, a record linkage study of young people in NSW who were treated for alcohol problems between 2001 to 2016 showed that those who spent at least 30 days in treatment were much less likely to be subsequently hospitalised for physical injuries (hazard ratio 0.77 [95% confidence interval 0.61–0.98]) and also range of other reasons [41]. This is particularly important given that accidental injuries are one of the leading causes of death among 15 to 24 year-olds in Australia, contributing to 32% of deaths in this age group from 2017 to 2019 [42].

Hospitalisation rates for any cause in the 12 months following the index event were 20% lower in the early adolescent group and 11% lower in the late adolescent group compared to the young adult group. This may be in part due to rates of all-cause hospitalisations being lower across adolescents in the NSW population compared to young adults [43] rather than cohort-specific effects. Compared to age-matched 12-month NSW population estimates, however, ED presentation rates in our cohort in the 12 months subsequent to the index event were at least three times higher [44] and hospitalisation rates in our cohort at least four times higher [43]. Evidence from Denmark suggests that adults who have been hospitalised for alcohol problems were much more likely to have subsequent admissions compared to the general population [17], though it is unclear whether this varies by age and whether similar results can be found in the Australian population. Extensions to our current work would benefit from comparisons in rates of cause-specific and all-cause ED presentations and hospitalisations between the Australian population of young people and young people who have previously had an alcohol-related issue to identify whether there are differences in morbidity.

4.1 | Limitations

Due to the nature of linked administrative data, our study has several limitations that should be considered. As the data were not collected for the purposes of this study, we were unable to adjust for confounders such as parent/family alcohol use. ED records only included those from public hospitals and the proportion of participating EDs has increased over time, from around 30% in 1996 to around 60% in 2010. Additionally, secondary diagnosis fields were not provided in ED records and alcohol-related diagnoses may not be recorded by staff at EDs. Given that most alcohol-related events for young people are ED presentations, it is likely due to the aforementioned limitations that there has been under-ascertainment of ED cases for alcohol-related problems [45]. Diagnosis codes collected from routine administrative data may be inaccurate due to errors such as poor communication between patients and clinicians, as well as lack of clinician experience and code-specific training [46]. Diagnosis codesets also differed between APDC (ICD-10-AM) and EDDC (SNOMED-CT-AU) which may have impacted diagnosis groupings as we were unable to match all SNOMED-CT-AU to ICD-10-AM codes, although minimal records were impacted. Finally, our follow-up was restricted to 12 months, which may be insufficient to examine the effect of age at first event on subsequent health outcomes for younger people in our cohort. Future work should extend the follow-up period and examine outcomes in adulthood.

5 | CONCLUSIONS

Young people who present to an ED or are hospitalised for the first time with an alcohol-related reason at a

younger age are more likely to be female, experience an ED presentation, and to present with mental or behavioural condition. Adolescents are also subsequently more likely to present to an ED for a non-poisoning injury compared to young adults. Our findings highlight preventable hospital events among young people who have experienced an alcohol-related ED presentation or hospitalisation, with age-specific clinical characteristics and outcomes that can be used to inform future health policy and service planning.

AUTHOR CONTRIBUTIONS

Each author certifies that their contribution to this work meets the standards of the International Committee of Medical Journal Editors.

ACKNOWLEDGEMENT

Open access publishing facilitated by University of New South Wales, as part of the Wiley - University of New South Wales agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

The National Centre for Youth Substance Use Research, National Drug Research Institute and National Drug and Alcohol Research Centre, and National Drug Research Institute are supported by funding from the Australian Government Department of Health under the Drug and Alcohol Programme. The Data-Linkage Alcohol Cohort Study was funded by research support funds awarded by UNSW Sydney to Amy Peacock. Wing S. Yuen is supported by PhD scholarships from the Australian Government under the Research Training Programme and National Drug and Alcohol Research Centre. Janni Leung is supported by the University of Queensland Development Fellowship. Amy Peacock, Janni Leung and Louisa Degenhardt are supported by National Health and Medical Research Council research fellowships (#1109366/#1174630 and #1041472/#1135991). Natasa Gisev is supported by a UNSW Scientia Fellowship. Louisa Degenhardt is supported by NIH grant NIDA R01DA1104470.

CONFLICT OF INTEREST

Michael Farrell has received untied educational grants from the Australian Government Department of Health. Louisa Degenhardt has received investigator-initiated untied educational grants for studies of opioid medications in Australia from Indivior, Reckitt Benckiser, Mundipharma and Seqirus. Amy Peacock has received investigator-initiated untied educational grants from Mundipharma and Seqirus for post-marketing surveillance of pharmaceutical opioids. These parties had no role in the study design, conduct, and reporting. All other authors have no conflicts of interest to declare.

ORCID

Wing S. Yuen https://orcid.org/0000-0002-2791-6858
Janni Leung https://orcid.org/0000-0001-5816-2959
Nicola Man https://orcid.org/0000-0003-2224-9301
Vivian Chiu https://orcid.org/0000-0002-8729-3330
Natasa Gisev https://orcid.org/0000-0003-0452-8470
Michael Livingston https://orcid.org/0000-0002-8995-9386
Louisa Degenhardt https://orcid.org/0000-0002-8513-2218
Adrian Dunlop https://orcid.org/0000-0003-2394-5966
Amy Peacock https://orcid.org/0000-0002-5705-2026

REFERENCES

1. Mokdad AH, Forouzanfar MH, Daoud F, Mokdad AA, El Bcheraoui C, Moradi-Lakeh M, et al. Global burden of diseases, injuries, and risk factors for young people's health during 1990–2013: a systematic analysis for the global burden of disease study 2013. Lancet. 2016;387:2383–401.
2. World Health Organization. Global status report on alcohol and health 2018. Geneva: World Health Organization; 2018.
3. Australian Bureau of Statistics. In: Statistics ABo, editor. National Health Survey: First Results, 2017–18. Canberra, Australia: Australian Bureau of Statistics; 2019.
4. Degenhardt L, Stockings E, Patton G, Hall WD, Lynskey M. The increasing global health priority of substance use in young people. Lancet Psychiatry. 2016;3:251–64.
5. Britton A, Ben-Shlomo Y, Benzeval M, Kuh D, Bell S. Life course trajectories of alcohol consumption in the United Kingdom using longitudinal data from nine cohort studies. BMC Med. 2015;13:47.
6. Yuen WS, Chan G, Bruno R, Clare P, Mattick R, Aiken A, et al. Adolescent alcohol use trajectories: risk factors and adult outcomes. Pediatrics. 2020;146:e20200440.
7. Donovan JE, Molina BS. Types of alcohol use experience from childhood through adolescence. J Adolesc Health. 2013;53:453–9.
8. Leggat G, Livingston M, Kuntsche S, Callinan S. The development of drinking trajectories among Australian young adults. J Stud Alcohol Drugs. 2021;82:237–45.
9. Wiesner M, Weichold K, Silbereisen RK. Trajectories of alcohol use among adolescent boys and girls: identification, validation, and sociodemographic characteristics. Psychol Addict Behav. 2007;21:62–75.
10. Danielsson AK, Wennberg P, Tengstrom A, Romelsjo A. Adolescent alcohol use trajectories: predictors and subsequent problems. Addict Behav. 2010;35:848–52.
11. Silins E, Horwood LJ, Najman JM, Patton GC, Toumbourou JW, Olsson CA, et al. Adverse adult consequences of different alcohol use patterns in adolescence: an integrative analysis of data to age 30 years from four Australasian cohorts. Addiction. 2018;113:1811–25.

12. Mewton L, Teesson M, Slade T, Grove R. The epidemiology of DSM-IV alcohol use disorders amongst young adults in the Australian population. Alcohol Alcohol. 2011;46:185–91.
13. Grant BF, Goldstein RB, Saha TD, Chou SP, Jung J, Zhang H, et al. Epidemiology of DSM-5 alcohol use disorder: results from the National Epidemiologic Survey on alcohol and related conditions III. JAMA Psychiat. 2015;72:757–66.
14. White AM, Hingson RW, Pan IJ, Yi HY. Hospitalizations for alcohol and drug overdoses in young adults ages 18-24 in the United States, 1999-2008: results from the nationwide inpatient sample. J Stud Alcohol Drugs. 2011;72:774–86.
15. Lensvelt E, Gilmore W, Gordon E, Hobday M, Liang W, Chikritzhs T. Trends in estimated alcohol-related emergency department presentations in Australia, 2005–06 to 2011–12. Perth: Curtin University; 2015.
16. White AM, Slater ME, Ng G, Hingson R, Breslow R. Trends in alcohol-related emergency department visits in the United States: results from the nationwide emergency department sample, 2006 to 2014. Alcohol Clin Exp Res. 2018;42:352–9.
17. Askgaard G, Leon DA, Deleuran T, Tolstrup JS. Hospital admissions and mortality in the 15 years after a first-time hospital contact with an alcohol problem: a prospective cohort study using the entire Danish population. Int J Epidemiol. 2020;49:94–102.
18. Peacock A, Chiu V, Leung J, Dobbins T, Larney S, Gisev N, et al. Protocol for the Data-Linkage Alcohol Cohort Study (DACS): investigating mortality, morbidity and offending among people with an alcohol-related problem using linked administrative data. BMJ Open. 2019;9:e030605.
19. Lawrence G, Dinh I, Taylor L. The Centre for Health Record Linkage: a new resource for health services research and evaluation. Health Inf Manag. 2008;37:60–2.
20. Australian Institute of Health and Welfare. National Drug Strategy Household Survey 2019. Canberra: AIHW; 2020.
21. Weinberg L, Wyatt JP. Children presenting to hospital with acute alcohol intoxication. Emerg Med J. 2006;23:774–6.
22. Woolfenden S, Dossetor D, Williams K. Children and adolescents with acute alcohol intoxication/self-poisoning presenting to the emergency department. Arch Pediatr Adolesc Med. 2002;156:345–8.
23. Australian Bureau of Statistics. In: Statistics ABo, editor. Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure. Canberra, Australia: Australian Bureau of Statistics; 2016. p. 23.
24. Australian Bureau of Statistics. In: Stantistics ABo, editor. Socio-economic indexes for areas 2011. Canberra, Australia: Australian Bureau of Statistics; 2013.
25. Guerin N, White V. ASSAD 2017 statistics & trends: trends in substance use among Australian secondary students. Victoria: Cancer Council; 2020.
26. MacArthur GJ, Smith MC, Melotti R, Heron J, Macleod J, Hickman M, et al. Patterns of alcohol use and multiple risk behaviour by gender during early and late adolescence: the ALSPAC cohort. J Public Health (Oxf). 2012;34(Suppl 1):i20–30.
27. Mumenthaler MS, Taylor JL, O'Hara R, Yesavage JA. Gender differences in moderate drinking effects. Alcohol Res Health. 1999;23:55–64.
28. Bouthoorn SH, van Hoof JJ, van der Lely N. Adolescent alcohol intoxication in Dutch hospital centers of pediatrics: characteristics and gender differences. Eur J Pediatr. 2011;170:1023–30.
29. Trefan L, Gartner A, Alcock A, Farewell D, Morgan J, Fone D, et al. Epidemiology of alcohol-related emergency hospital admissions in children and adolescents: an e-cohort analysis in Wales in 2006-2011. PLoS One. 2019;14:e0217598.
30. Meister SR, Barker B, Flores-Pajot MC. Student suggestions for addressing heavy episodic drinking. J Am Coll Heal. 2022;70:517–26.
31. Miller MB, Merrill JE, Singh S, DiBello AM, Carey KB. College student knowledge of blackouts and implications for alcohol intervention: a qualitative analysis. Psychol Addict Behav. 2018;32:933–43.
32. Centre for Epidemiology and Evidence. HealthStats NSW population estimates NSW by age for persons by remoteness category Sydney: NSW Ministry of Health. Available from: https://www.healthstats.nsw.gov.au/#/r/100198.
33. Chan GC, Leung J, Quinn C, Kelly AB, Connor JP, Weier M, et al. Rural and urban differences in adolescent alcohol use, alcohol supply, and parental drinking. J Rural Health. 2016;32:280–6.
34. Katikireddi SV, Whitley E, Lewsey J, Gray L, Leyland AH. Socioeconomic status as an effect modifier of alcohol consumption and harm: analysis of linked cohort data. Lancet Public Health. 2017;2:e267–e76.
35. Kendler KS, Gardner CO, Hickman M, Heron J, Macleod J, Lewis G, et al. Socioeconomic status and alcohol-related behaviors in mid- to late adolescence in the Avon longitudinal study of parents and children. J Stud Alcohol Drugs. 2014;75:541–5.
36. Boyd J, Sexton O, Angus C, Meier P, Purshouse RC, Holmes J. Causal mechanisms proposed for the alcohol harm paradox-a systematic review. Addiction. 2022;117:33–56.
37. Roche A, Kostadinov V, Fischer J, Nicholas R, O'Rourke K, Pidd K, et al. Addressing inequities in alcohol consumption and related harms. Health Promot Int. 2015;30(Suppl 2):ii20–35.
38. Taylor B, Irving HM, Kanteres F, Room R, Borges G, Cherpitel C, et al. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug Alcohol Depend. 2010;110:108–16.
39. Indig D, Copeland J, Conigrave KM, Rotenko I. Why are alcohol-related emergency department presentations underdetected? An exploratory study using nursing triage text. Drug Alcohol Rev. 2008;27:584–90.
40. Fulde GW, Smith M, Forster SL. Presentations with alcohol-related serious injury to a major Sydney trauma hospital after 2014 changes to liquor laws. Med J Aust. 2015;203:366.
41. Whitten T, Cale J, Nathan S, Bista S, Ferry M, Williams M, et al. Hospitalisation following therapeutic community drug and alcohol treatment for young people with and without a history of criminal conviction. Drug Alcohol Depend. 2022;231:109280.
42. Australian Institute of Health and Welfare. Australia's youth: unintentional injuries: AIHW, Australian government 2021. Available from: https://www.aihw.gov.au/reports/children-youth/unintential-injuries.

43. Centre for Epidemiology and Evidence. HealthStats NSW Hospitalisations for all causes Sydney: NSW ministry of health. Available from: https://www.healthstats.nsw.gov.au/#/r/100199.
44. Centre for Epidemiology and Evidence. HealthStats NSW emergency department presentations Sydney. Available from: https://www.healthstats.nsw.gov.au/#/r/100200.
45. Egerton-Warburton D, Gosbell A, Wadsworth A, Fatovich DM, Richardson DB. Survey of alcohol-related presentations to Australasian emergency departments. Med J Aust. 2014;201:584–7.
46. O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. Health Serv Res. 2005;40:1620–39.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Yuen WS, Leung J, Man N, Chiu V, Gisev N, Livingston M, et al. Age at first alcohol-related hospital separation or emergency department presentation and rate of re-admission: A retrospective data linkage cohort of young Australians. Drug Alcohol Rev. 2022;41(7): 1577–88. https://doi.org/10.1111/dar.13529