

# Population patterns in Alcohol Use Disorders Identification Test (AUDIT) scores in the Australian population; 2007–2016

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Alcohol continues to be a significant cause of morbidity and mortality, estimated to account for 4.6% of the total burden in Australia in 2011.<sup>1</sup> Aside from individual harm, there are significant social and economic costs,<sup>2</sup> and at a population level, any proposed protective health effects of alcohol are far outweighed by the negative effects.<sup>3</sup> Harmful patterns of drinking have both acute and chronic health risks that are often underestimated by individuals. What's more, risky drinkers are more likely to believe they can consume excess alcohol without putting their health at risk than low-risk drinkers.<sup>4</sup>

Australian alcohol consumption has changed significantly in recent years.<sup>5</sup> Per capita alcohol consumption has been declining since around 2008, reaching a low in 2017 not seen since the early sixties.<sup>5</sup> Importantly, this decline has not been evenly distributed among the population.<sup>6</sup> Recent work shows clear reductions in teenage drinking,<sup>6</sup> but there is evidence that consumption in the heaviest drinkers has remained unchanged in other age groups.<sup>4,6</sup> In this changing landscape, it is imperative to monitor the distribution of drinking patterns in different population groups so that problematic trends can be promptly identified. National survey data are a vital resource for monitoring these trends and can provide us with reasonably accurate estimates of actual consumption patterns for the general population,<sup>7</sup> enabling

## Abstract

**Objectives:** Despite widespread use of the Alcohol Use Disorders Identification Test (AUDIT), there are no published contemporary population-level scores for Australia. We examined population-level AUDIT scores and hazardous drinking for Australia over the period 2007–2016.

**Methods:** Total population, age- and gender-specific AUDIT scores, and the percentage of the population with an AUDIT score of 8 or more (indicating hazardous drinking), were derived from four waves of the nationally representative National Drug Strategy Household Survey, weighted to approximate the Australian population.

**Results:** In 2016, the mean AUDIT score was 4.58, and 22.22% of the population scored  $\geq 8$ . Both measures remained stable from 2007 to 2010 but declined in 2013 and 2016. Scores were highest in those aged 18–24 years, the lowest in those aged 14–17 or 60+. A downward trend in AUDIT scores was seen in younger age groups, while the 40–59 and 60+ groups increased or did not change.

**Conclusions:** Despite an overall decline in AUDIT scores, nearly one-quarter of Australians reported hazardous drinking.

**Implications for public health:** The marked declines in hazardous drinking among young people are positive, but trends observed among those aged 40–59 and 60+ years suggests targeted interventions for older Australians are needed.

**Key words:** alcohol, trends, surveys, Australia

comparison between different demographic groups in Australia and with other high-income countries such as Sweden, where patterns of alcohol consumption in the general population have been surveyed for decades.<sup>8</sup>

Various tools have been used to screen populations for harmful alcohol use, including the Alcohol Use Disorders Identification Test (AUDIT).<sup>9</sup> The AUDIT is a simple, internationally validated and reliable method of screening for hazardous drinking and

dependence,<sup>9</sup> which has been used in a range of studies including surveys of the general population and clinical studies.<sup>10</sup> The AUDIT has been found to have excellent sensitivity and specificity in many populations,<sup>10</sup> and its use worldwide facilitates comparison between countries.<sup>9</sup> The AUDIT can help determine a person's level of risk in a step-wise fashion – from screening positive for hazardous (sometimes called 'risky') drinking and harmful drinking, to alcohol dependence.<sup>9</sup> Hazardous drinkers are those

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Submitted: April 2020; Revision requested: August 2020; Accepted: September 2020

The authors have stated the following conflict of interest: JD's institution receives investigator-initiated research funding from Gilead Sciences, AbbVie, Merck and Bristol Myers Squibb.

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*Aust NZ J Public Health.* 2020; 44:462-7; doi: 10.1111/1753-6405.13043

whose drinking increases their risk of harmful consequences for themselves or others, while harmful use refers to drinkers whose drinking has already resulted in harmful consequences to their physical and mental health.<sup>9</sup> The ICD-10 defines dependency as “a cluster of behavioural, cognitive and physiological phenomena that can develop after repeated alcohol use”.<sup>11</sup> This analysis focuses only on hazardous drinking.

While other studies have looked at general trends in alcohol consumption,<sup>5–7,12</sup> we could find no contemporary peer-reviewed published studies of Australian AUDIT scores, and only two studies of international trends in AUDIT scores over time, based on national population surveys.<sup>8,13</sup> These are important to understand given the widespread use of the AUDIT in clinical samples. To address this gap, our study was designed to measure trends in AUDIT scores and the prevalence of hazardous drinking in the Australian population over time. This paper provides the first analysis of changes in Australian AUDIT scores from 2007 to 2016 and will serve as a benchmark for future research in this area.

## Methods

### Study design

We used data from four successive cross-sectional waves of the National Drug Strategy Household Survey (NDSHS) to estimate trends in AUDIT scores over time. The NDSHS is a long-running cross-sectional household survey that collects information on alcohol and drug use patterns, attitudes and behaviours from a representative sample of the Australian population every three years.<sup>4</sup> We used NDSHS waves from 2007, 2010, 2013 and 2016, as AUDIT questions have only been consistently included since 2007.

### Sample

The study population consisted of all complete responses from respondents aged 14 years or over with sampling weights

applied to approximate the age, sex, household size and geographic distribution of the general Australian population for the year in question.<sup>14,15</sup> A multi-stage stratified random sample design was used.<sup>4</sup> Further details on the methodology and sampling strategy can be found in related publications.<sup>14,15</sup> The unweighted sample size was 96,015, and respondents ranged in age from 14–98 years. Missing data represented 6.02% (n=5,779) of unweighted values, which were dropped from the analysis (applied to AUDIT scores and their derivatives only). A description of the study sample and key features by survey year is shown in Table 1.

### Instrument

The AUDIT is a 10-item questionnaire, made up of three domains: 1) alcohol use (consumption); 2) dependence symptoms; and 3) alcohol-related problems.<sup>9</sup> The AUDIT questionnaire and response items can be found in Supplementary Table S1. Scores for each item range from 0–4 resulting in total scores that range from 0–40, which can be categorised into four risk levels described in Table 2.<sup>9</sup> A drinker is defined here as anyone who reports consuming alcohol in the previous 12 months.<sup>4</sup> In the NDSHS, items 4–10 of the AUDIT are asked in the same format as in the AUDIT, but items 1–3 are asked as part of a series of questions on alcohol consumption. The answers to these items can be converted into AUDIT form by approximating some of the answers to the most appropriate equivalent. Item 1 of the AUDIT is derived from questions in the NDSHS such as: “Have you ever tried alcohol?”; “Have you ever had a full serve of alcohol?”; “Have you had an alcoholic drink of any kind in the last 12 months?”; and “In the last 12 months, how often did you have an alcoholic drink of any kind?” Item 2 on the AUDIT consists of usual quantity consumed per occasion in terms of standard drinks, which was derived from a similar item in the NDSHS: “On a day that you have an alcoholic drink, how

many standard drinks do you usually have?” The response options for these questions in the NDSHS were coded into the most appropriate AUDIT response options. Item 3 consists of how often an individual consumes 60g or more of alcohol on one occasion. This was approximated from a graduated frequency measure where the number of times an individual reported drinking 5–6, 7–10, 11–19 and 20 or more standard drinks were combined, with respondents then categorised into the most appropriate AUDIT category. This equates to drinking 50g of alcohol or more on an occasion rather than 60g or more, as in the original AUDIT. In the NDSHS, a standard drink contains 10g of alcohol. An AUDIT score of 8 or more was used to indicate hazardous drinking in this study population.

### Variables

The main outcome variable was the total AUDIT score. From this, a binary variable describing an AUDIT score of 8 or more (corresponding to hazardous drinking) was generated. A secondary outcome of this study was the percentage of the population in each of the AUDIT risk levels, represented by an ordinal variable derived from the total AUDIT score. The main explanatory variable was survey year. Other independent variables included age (14–17, 18–24, 24–29, 30–39, 40–59 and 60+ years) and gender (male/female).

### Analyses

The Stata (College Station, USA, version 15.1)<sup>16</sup> svy suite of commands was used to account for the complex survey design. The 18–24 age group was selected as the reference category to facilitate interpretation of findings, as this is the youngest age group legally able to purchase alcohol in Australian states and territories. Adjusted

Table 1: Description of study sample and key features by survey year.<sup>4</sup>

Year	Complete responses <sup>a</sup>	Response rate	Missing data	Sample <sup>b</sup>	Weighted sample	Completion methods
2007	22,912	54%	1,451 (6.33%)	21,461	16,125,433	Drop and collect, CATI
2010	26,157	50.6%	1,533 (5.86%)	24,624	16,973,898	Drop and collect
2013	23,521	49.1%	1,551 (6.59%)	21,970	17,449,347	Drop and collect
2016	23,425	51.1%	1,244 (5.31%)	22,181	18,810,225	Multimode <sup>c</sup>

Notes:

a: Complete responses exclude < 14s

b: Sample excludes < 14s & missing data

c: Multimode = drop and collect, paper, online, and CATI (computer-assisted telephone interview) completion modes

Table 2: AUDIT risk levels and graded interventions.

AUDIT score	Risk level	Intervention
0–7	Low risk/abstainer	Feedback
8–15	Medium risk/hazardous use	Brief intervention
16–19	High risk/harmful use	Brief intervention, further monitoring and evaluation
20–40	Very high risk/possible dependence	Referral to specialist treatment

Note:

Adapted from Babor et al. (2001).<sup>9</sup>

Wald tests were used to test for differences between proportions and means. Logistic regression analyses were used to examine the relationship between hazardous drinking, and age and gender over the four survey waves. Multiple linear regression using the log-transformed AUDIT summary score was used to examine the relationship between mean AUDIT score and other variables. Interaction terms between year and age group were used to assess whether shifts in outcome measures in different sub-groups occurred over this time period. Results are presented for the general population with missing data excluded. Results of the most recent survey are described in detail. Weights have been applied unless otherwise stated, which may result in small discrepancies in results due to rounding.

## Results

Main outcome measures for the total population and for men and women are shown in Table 3. Output from the regression analyses is shown in Table 4. Tables of age- and gender-specific values of main outcome measures (S2, S3), gender-specific AUDIT risk levels (S4), and odds ratios of hazardous drinking by age group comparing survey years (S5) can be found in the Supplementary material.

### Trends in hazardous drinking

Overall, the prevalence of hazardous drinking was stable through to 2010; it then declined through to 2016 (Table 3). Trends in hazardous drinking for each gender are shown in Figure 1. More males screened positive for hazardous drinking than females and hazardous drinking was highest in the 18–24 age group. This pattern was evident in the results of our regression analyses, which showed significant main effects for survey year, age group and gender, and a significant interaction between time and age group (Table 4). The interaction between survey year and age group was such that, relative to a general decline in prevalence over time evident for 18–24-year-olds, the 14–17 age group showed a bigger decline while the older age groups (40–59, and 60+) showed a smaller decline, or even an increase in the prevalence of hazardous drinking. The pattern for the 24–29-year-olds was equivalent to the 18–24-year-olds.

### Trends in mean AUDIT scores

The pattern for the mean AUDIT score in the Australian population was similar to the hazardous drinking pattern above, in that mean scores remained stable from 2007 to 2010, then declined in 2013 and 2016 (Table 3). Trends for each gender are shown in Figure 2. Males had higher mean AUDIT scores than females across all sub-groups, and mean

AUDIT score was highest in males aged 18–24 and 24–29 years, and females aged 18–24 years. Lowest scores were found in the over-sixties initially but were superseded by a declining trend in the youngest age group in 2013 and 2016. As for the regression analysis of hazardous drinking, the analysis of total AUDIT score supported these findings, with significant main effects for year, age group

Table 3: Key AUDIT outcomes with 95% confidence intervals by survey year.

	2007	2010	2013	2016
<b>Hazardous drinking (%)</b>				
All	25.25 (24.53-25.98)	25.81 (25.15-26.48)	23.55 (22.88-24.24)	22.22 (21.55-22.91)
Male	33.79 (32.62-34.97)	34.09 (33.03-35.16)	31.77 (30.67-32.89)	29.60 (28.52-30.71)
Female	16.89 (16.10-17.71)	17.67 (16.91-18.45)	15.42 (14.68-16.19)	14.99 (14.22-15.78)
<b>Mean AUDIT score</b>				
All	5.14 (5.05-5.23)	5.13 (5.05-5.21)	4.79 (4.71-4.87)	4.58 (4.50-4.67)
Male	6.26 (6.11-6.41)	6.28 (6.15-6.42)	5.85 (5.71-5.98)	5.56 (5.42-5.70)
Female	4.05 (3.95-4.15)	3.99 (3.90-4.08)	3.74 (3.65-3.84)	3.63 (3.53-3.72)

Table 4: Multiple logistic and linear regression analyses of AUDIT outcome measures with year, age group and gender.

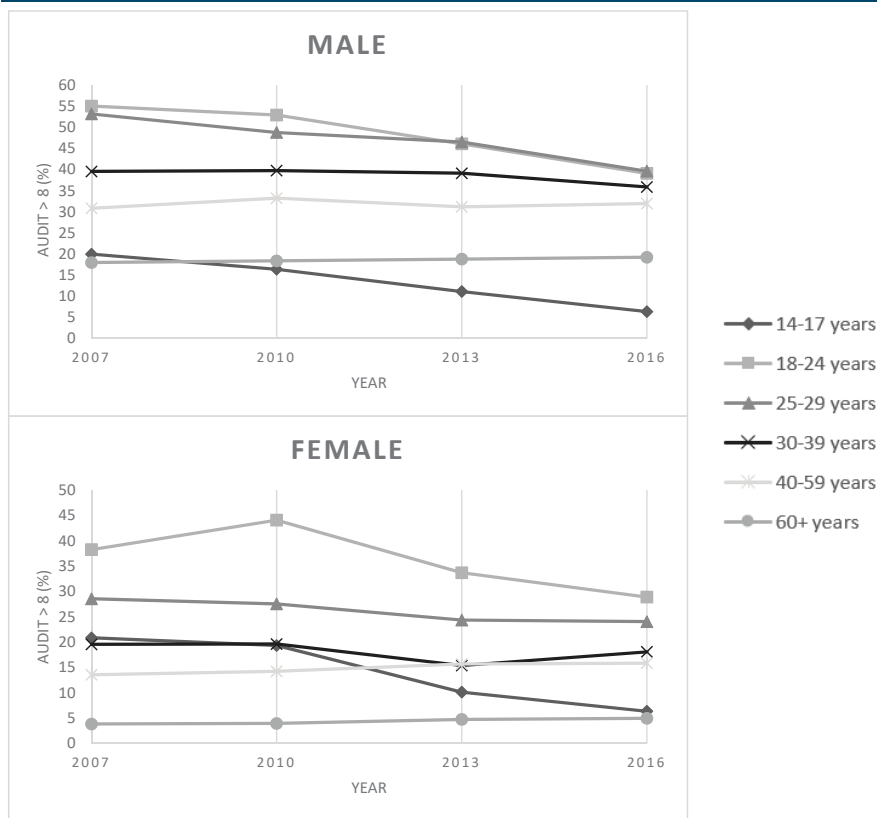
Characteristic	Logistic regression	Linear regression
	Hazardous drinking adjusted odds ratio (95%CI)	Total AUDIT score coefficient <sup>a</sup> (95%CI)
<b>Year</b>		
2007	Reference	Reference
2010	1.07 (0.91, 1.26)	-0.00 (-0.07, 0.07)
2013	0.75 (0.63, 0.88)**	-0.14 (-0.21, -0.07)**
2016	0.56 (0.47, 0.67)**	-0.27 (-0.35, -0.20)**
<b>Age group</b>		
14-17 years	0.27 (0.22, 0.34)**	-0.49 (-0.60, -0.39)**
18-24 years	Reference	Reference
25-29 years	0.78 (0.65, 0.94)*	-0.19 (-0.27, -0.12)**
30-39 years	0.46 (0.40, 0.54)**	-0.40 (-0.46, -0.34)**
40-59 years	0.31 (0.27, 0.36)**	-0.53 (-0.58, -0.48)**
60+ years	0.13 (0.11, 0.15)**	-0.74 (-0.79, -0.68)**
<b>Sex</b>		
Male	Reference	Reference
Female	0.40 (0.38, 0.41)**	-0.41 (-0.42, -0.39)**
<b>Age group x year</b>		
18-24 years x 2007	Reference	Reference
14-17 years x 2010	0.80 (0.58, 1.09)	0.12 (0.04, 0.27)
14-17 years x 2013	0.61 (0.42, 0.88)*	0.01 (-0.15, 0.18)
14-17 years x 2016	0.46 (0.30, 0.70)**	0.01 (-0.19, 0.21)
25-29 years x 2010	0.83 (0.65, 1.06)	0.01 (-0.09, 0.12)
25-29 years x 2013	1.06 (0.82, 1.35)	0.06 (-0.05, 0.16)
25-29 years x 2016	1.19 (0.92, 1.54)	0.12 (0.01, 0.23)*
30-39 years x 2010	0.94 (0.77, 1.15)	0.03 (-0.05, 0.11)
30-39 years x 2013	1.20 (0.97, 1.47)	0.09 (0.00, 0.17)*
30-39 years x 2016	1.56 (1.26, 1.93)**	0.23 (0.14, 0.32)**
40-59 years x 2010	1.02 (0.85, 1.24)	0.03 (-0.05, 0.10)
40-59 years x 2013	1.44 (1.19, 1.75)**	0.17 (0.09, 0.25)**
40-59 years x 2016	1.96 (1.61, 2.40)**	0.30 (0.21, 0.38)**
60+ years x 2010	0.96 (0.78, 1.18)	-0.02 (-0.10, 0.05)
60+ years x 2013	1.47 (1.19, 1.82)**	0.12 (0.04, 0.20)*
60+ years x 2016	2.02 (1.63, 2.50)**	0.24 (0.16, 0.32)**

Notes:

a: From linear regression model using log-transformed AUDIT variable

\* $p < 0.05$ ; \*\* $p < 0.001$

Figure 1: Trends in hazardous drinking by age group.



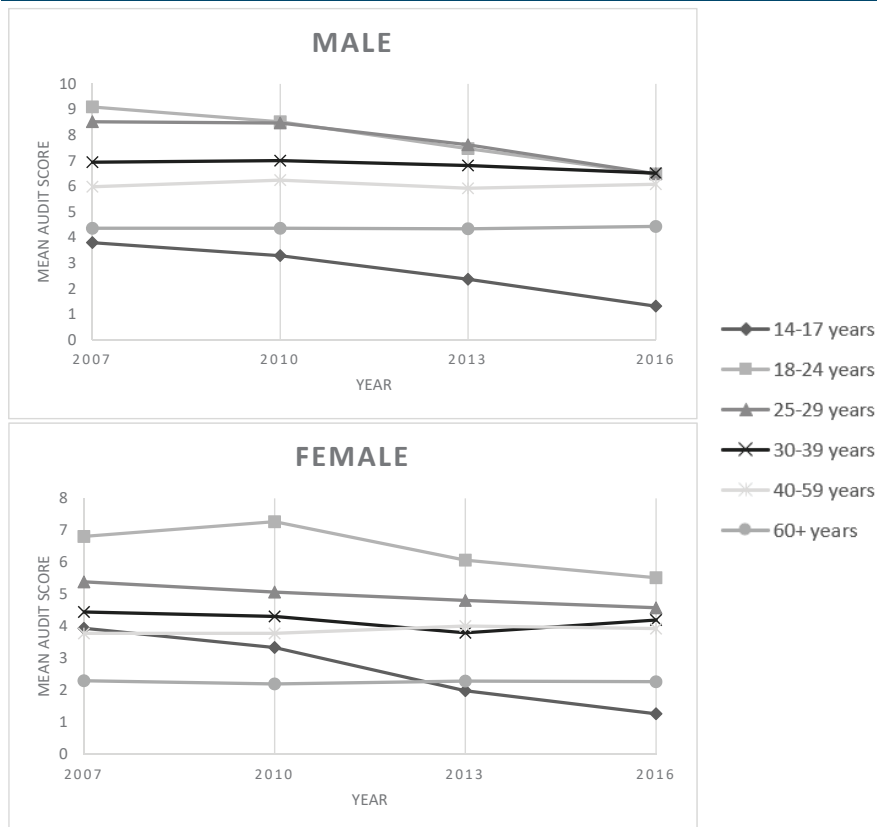
and gender, and a significant interaction between time and age group as shown in Table 4.

### Discussion

#### Principal findings

In representative surveys of the Australian population, both mean AUDIT scores and the prevalence of hazardous drinking remained stable from 2007 to 2010, then declined in 2013 and 2016, reaching a low for the study period in 2016. These findings are consistent with data from the Australian Bureau of Statistics on per capita alcohol consumption.<sup>5</sup> However, these favourable downward trends in hazardous drinking and mean AUDIT scores in the population overall are made up of varying trends, with marked declines in younger populations and stable or slightly increasing levels in older populations. It is unclear what is causing the divergence in trends by age. For example, Skog's theory of the collectivity of drinking cultures would predict a general left-shift in the drinking distribution of society as a whole, as changes in mean alcohol consumption are theorised to occur across all levels of consumption, interconnected and influenced by social norms.<sup>17</sup> Our findings of a mixed pattern are consistent with cohort effects that need further research to understand.

Figure 2: Trends in mean AUDIT score by age group.



Trends in population AUDIT scores are available for Sweden since 1997.<sup>8</sup> These trends show a different pattern over time to that observed in our study, with a peak in Swedish AUDIT scores in 2001<sup>18</sup> that was followed by a decline to 2009<sup>19</sup> and relative stability from 2009 through to 2018.<sup>8,20</sup> In contrast to our study that demonstrated a decline in mean AUDIT scores for both genders, for Swedish men, mean AUDIT scores decreased slightly over this time period, but they remained unchanged for Swedish women.<sup>8</sup> However, our findings of a decline in AUDIT scores among younger age groups are also evident in the Swedish studies. In Japan, Osaki et al. found that Japanese AUDIT scores (using a higher cut-off for hazardous drinking) showed a similar pattern to the Swedish studies with a decline evident from 2003 to 2008, and with relative stability from 2008 to 2013.<sup>13</sup>

The drop in AUDIT scores and harmful drinking found in the younger age groups in the current study align with the growing body of work on declining youth drinking.<sup>21-23</sup> The 18–24 age group had the highest mean



AUDIT score and prevalence of hazardous drinking of all age groups, but within this group, a clear decline in consumption was still evident. Declines in youth drinking are not unique to Australia. A large study examining trends in adolescent alcohol use across 28 North American and European countries from 2002 to 2010 demonstrated a decline in weekly alcohol use in 20 out of 28 countries, apparent in all gender and age sub-groups.<sup>24</sup>

Historically, there has been a trend for older people's consumption to decline. It has been postulated that female baby boomers may be bucking this trend, as this is the first female generation for whom it has been socially acceptable to drink alcohol frequently.<sup>25</sup> However, research based on an Australian longitudinal study found no evidence to support this cohort effect theory.<sup>26</sup> Figures 1 and 2 clearly show a lack of decline in outcome measures in older age groups, particularly the 40–59 and 60+ age groups in both genders. This finding supports other work showing that a sub-set of older people are failing to reduce their drinking as they get older.<sup>27</sup> Although the changes among older age groups are small, in a rapidly ageing population they are cause for concern. Older people have a reduced capacity to metabolize alcohol,<sup>28</sup> even if their consumption remains the same their risk may still increase.

Many theories have been postulated to explain the downward trends in alcohol consumption and hazardous use. Changing social norms, economic pressures, significant investments in health promotion and prevention programmes, the effect of social media, changes in parenting practices, and an increased awareness of the detrimental health effects of alcohol<sup>29–31</sup> are all proposed as explanations for this decline. A recent Australian study based on the NDSHS reported different reasons for reducing or quitting alcohol for different age groups and genders, with younger people more likely to reduce their intake for lifestyle, social and financial reasons or taste/enjoyment, and older people for health reasons.<sup>30</sup> This combined with the declines in youth drinking in Australia may indicate that the position of alcohol in Australian society is changing.

### Strengths and limitations

An overall strength of this study is its large sample size and representativeness of the general Australian population due to the sampling and weighting strategy used.<sup>14,15</sup> Nevertheless, there are some limitations.

First, the wording of items in the NDSHS that we used to derive AUDIT items 1–3 is different to the actual items used in the AUDIT. Similar methodologies were used for each survey making them reasonably comparable, but changes to collection methods between years could potentially introduce bias.<sup>4</sup> The NDSHS sample is based on households and so excludes homeless and institutionalised persons and those living in hostels and motels.<sup>4</sup> Inadvertently excluding these groups from population surveys of alcohol use may underestimate the true prevalence of hazardous drinking in the population, as risky alcohol use is much higher in these populations.<sup>32</sup> Interviews were only conducted in English, thus restricting participation by non-English speakers. Survey estimates are vulnerable to non-sampling errors resulting from response, non-response and recall biases; however, the NDSHS attempts to adjust for non-response with its weighting strategy. Alcohol use and related harms are sensitive topics collected through self-report in the NDSHS, making them prone to recall and social desirability bias and potentially under-reported.<sup>33,34</sup> However, these biases are likely to be consistent over time and are not expected to have a major effect on the trend analysis. There is a small but not dismissible amount of missing data for AUDIT measures, which could introduce bias. Finally, this study used a cut-off of 8 or more to classify all respondents as hazardous drinkers, but a number of studies have found lower cut-offs for women to be more sensitive.<sup>10</sup>

### Conclusions

By applying the AUDIT to national survey data, we have demonstrated a relatively high burden of alcohol use disorders in the Australian population, making a robust case for strengthening preventive measures. Disaggregating the results by age and gender revealed several hidden trends. Our results support the findings of other contemporary research in this area demonstrating the changing trends in alcohol habits in young people.<sup>6,21–23</sup> There is a strong imperative to monitor these trends as it is likely that they will continue as this cohort ages, and so prevention programs and policy changes should be tailored to respond to these trends. The rise in alcohol consumption that was seen in 2018<sup>5</sup> is not explored in this study, and therefore the results of the next

wave of the Australian NDSHS are eagerly awaited. Further research should focus on understanding the reasons behind these changing trends and an examination of any age-period-cohort effects.

### Acknowledgement

We would like to acknowledge the Australian Institute of Health and Welfare for providing the National Drug Strategy Household Survey data and the Australian Data Archive for providing access to this data.

### Funding

HOB is funded by the Victorian Public Health Medicine Training Scheme (VPHMTS) programme. PD is the recipient of an NHMRC Senior Research Fellowship, ML is supported by an NHMRC Career Development Fellowship (1123840), SC is funded by Australian Research Council DECRA fellowship (DE180100016), and JD is an NHMRC Clinical Research Fellow. The authors gratefully acknowledge the support of the Victorian Operational Infrastructure Support Fund. The funders had no input into this work.

### Availability of data and materials

The datasets used in this study are available through the Australian Institute of Health and Welfare for research purposes, upon request from the Australian Data Archive.

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## Supporting Information

Additional supporting information may be found in the online version of this article:

**Supplementary File 1:** AUDIT questionnaire and responses.

**Supplementary File 2:** Prevalence of hazardous drinking with 95% confidence intervals by survey year.

**Supplementary File 3:** Mean AUDIT scores with 95% confidence intervals by survey year.

**Supplementary File 4:** Different risk levels by year.

**Supplementary File 5:** Odds ratios (and 95% confidence intervals) of hazardous drinking by age-group comparing survey years (adjusted for sex).