

# Alcohol-attributable deaths among indigenous and non-indigenous Australians

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## Abstract

### Introduction

Alcohol abuse in Indigenous communities in Australia has been a devastating problem. The association between alcohol use and ill-health is well established but complex. The aim of this review was to assess and compare alcohol-attributable deaths and years of life lost among Indigenous Australians to the Australian population as a whole.

### Methods and materials

Standard burden of disease and injury methodology and population attributable fractions were applied to analyse death registration data from 2003 to 2006. Alcohol use prevalence was retrieved from the 2004/5 Australian National Health Surveys and the National Aboriginal and Torres Strait Islander Health Survey. The relative risk estimates were compiled from epidemiological reviews.

### Results

The results found that Indigenous Australians experienced 7% to 7.5% mortality burden resulting from alcohol use, and were over-represented in comparison with their population share (2.5%). At ages 15 to 74 years, the alcohol-attributable deaths and years of life lost rates among Indigenous Australians were over 2–3 times higher than in the average across all Australians. At ages 25 to 54, the alcohol-attributable mortality rates among Indigenous Australians were

4–6 times higher than the national average. Alcohol-attributable mortality risk was substantially (2–3 times) higher among males than females, regardless of ethnicity and age group.

### Discussion

This review provides new and more reliable national data on alcohol-attributable deaths and alcohol-attributable years of life lost, comparing Indigenous Australians with the general population. Significant mortality and morbidity among Indigenous Australians is associated with excess alcohol use, which generally occurs within a historical context and socioeconomic disadvantage. The failure to address poverty in Indigenous communities is likely to undermine gains that might otherwise occur through traditional prevention activities, such as alcohol restrictions.

### Conclusion

It was evident that the harmful use of alcohol contributed to the disproportionate mortality burden experienced by Indigenous Australians.

### Introduction

Globally, 2.5 million (3.8% of total) deaths resulted from alcohol abuse in 2004, and harmful use of alcohol was responsible for 4.5% of the global burden of disease<sup>1</sup>. In 2010, 81% of Australians aged 14 years and over reported drinking alcohol, and 29% drank at harmful level<sup>2</sup>. The cost of alcohol use was estimated to be \$15 billion annually, with an additional \$1 billion due to the combined effects with illicit drugs<sup>3</sup>. In Australia, throughout 1990 to 2007 the national per capita consumption of alcohol increased steadily with some evidence of decline since 2008<sup>4,5</sup>, possibly related to the international

economic downturn. Vos and colleagues estimated that the burden of disease associated with alcohol use by Aboriginal and Torres Strait Islander (referred to as Indigenous hereafter) Australians is 6.2% of the overall burden of disease and injury, almost double that of the general Australian population<sup>6</sup>.

Indigenous Australians constitute 2.5% of the total Australian population<sup>7</sup>. Alcohol abuse among Indigenous communities has been a devastating problem. Harmful use of alcohol is the most prevalent form of substance abuse among Indigenous Australians<sup>8</sup>. Indigenous Australians are concerned about harmful alcohol use in their communities, and actively involved in prevention. Most Indigenous people do not drink alcohol at all or drink responsibly. In 2004–05, 49% of Indigenous and 52% all Australian adults reported having consumed alcohol in the week prior to interview, and 16% of Indigenous adults reported drinking at risky level<sup>8</sup>, far exceeding the all Australian average (8%)<sup>9</sup>. By balancing the information of various sources, there appears to be a consensus that the Indigenous population is less likely to consume alcohol than non-Indigenous Australians, mainly due to higher abstention rates. However, Indigenous Australians are at least 50% more likely to drink at harmful levels, and experience adverse effects of alcohol and higher levels of mortality and morbidity than their non-Indigenous peers<sup>10,11</sup>. This summary is supported by the large-scale surveys, national hospital data collection and death registration.

Alcohol misuse has negative effects on Indigenous life expectancy.

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Among alcohol-related deaths, 62% of Indigenous males and 70% of Indigenous females died before 55 years of age<sup>12</sup>. Australian Institute of Health and Welfare reported the Indigenous avoidable mortality rate from alcohol-related diseases was 9 times the non-Indigenous death rate over the period 2002–2006<sup>13</sup>. Indigenous people were hospitalised for alcohol related conditions at rates between 1.5 and 7.9 times those of other people in 2008–09<sup>14</sup>. Alcohol-attributable hospitalisation increased from 291 to 460 per 10,000 males and from 182 to 387 for females, 5–10 times the non-Indigenous rates between 1998 and 2009<sup>15</sup>. Excessive alcohol consumption is a recognised risk for chronic diseases<sup>16,17</sup>, cancers<sup>18,19</sup>, infectious disease<sup>20,21</sup>, child health conditions<sup>22</sup>, child neglect and abuse<sup>23</sup>, and maternal health conditions. A recent study indicated that the proportion of Indigenous mothers with an alcohol related diagnosis is 23%, ten times greater than for non-Indigenous mothers<sup>24</sup>. Alcohol consumption is also linked to family conflict<sup>25</sup>, imprisonment<sup>14,26</sup>, suicide<sup>27</sup>, and mental health<sup>28</sup>. The Indigenous population has a much higher rate of injury and motor vehicle accidents under the influence of alcohol and assault injuries<sup>25,29</sup>.

Chikritzhs et al. estimated that the alcohol-attributable death (AAD) rate among Indigenous people was 4.2 per 10,000 Australia-wide, but varied substantially by region, e.g. 0.8 per 10,000 in Tasmania versus 14.6 in the Central Australia region of the Northern Territory (NT)<sup>17</sup>. The NT has the highest per capita alcohol consumption of all states and territories in Australia<sup>30</sup>, reflecting the fact that high levels of consumption are experienced among both Indigenous and non-Indigenous populations. The Territory also has the largest Indigenous resident population of all jurisdictions (30% in 2011)<sup>31</sup>. In the NT, per capita consumption among

Indigenous people is approximately 1.97 times, and among non-Indigenous people about 1.43 times, the national average.

Alcohol-attributable deaths in the NT occurred at about 3.5 times the rate they did in Australia generally<sup>32</sup>. The South Australian Centre for Economic Studies estimated that in 2004/05 there were 120 deaths attributable to harmful use of alcohol, and the social cost amounted to \$642 million in the NT<sup>33</sup>. Not surprisingly, harmful use of alcohol is an important public policy issue in the NT.

Deaths due to alcohol consumption refer to any deaths caused by low risk, risky and high risk level of alcohol use<sup>34</sup>. Alcohol consumption is difficult to measure precisely. Retrospective data collection of health related behaviour typically relies on self-report methods. Self-report surveys of alcohol use and levels of drinking among the general population always underestimates overall levels of consumption when compared to what is known to have been consumed from independent sources (e.g. tax and customs data) and surveys of Indigenous persons may be particularly vulnerable to under-reporting of drinking prevalence<sup>10</sup>. This in turn may have implications for estimates of alcohol-attributable mortality and morbidity, and economic evaluations.

In Australia, Registries of Births, Deaths and Marriages consistently collect death data on underlying cause of death, demographic and geographic information including Indigenous status, age at death and sex. These high quality data may be used to inform estimates of AAD among Australians. Nevertheless, there appears a lack of data on comparing alcohol-attributable mortality between Indigenous and general Australian populations. The aim of this review was therefore to assess and compare AAD and years of life lost (YLL) between Indigenous Australians and the Australian population as a whole.

## Methods and materials

The Australian Bureau of Statistics (ABS) provided death registration data from 2003 to 2006 based on year of death. As a measure for premature mortality, YLL takes into account both number of deaths and age of death, in order to quantify the mortality burden caused by alcohol<sup>6</sup>. YLL<sub>j</sub> were estimated by summing up the standard life expectancies at the age of death for all individuals who died of disease j. The standard life expectancies by age and sex were sourced from the second Australian burden of disease and injury study<sup>35</sup>. We used ABS estimated resident population and Indigenous experimental population estimates by age group and sex as the denominators to derive age-sex specific death and YLL rates. The mortality data were corrected for under-identification using the under-identification rates provided by ABS for all states and territories<sup>7</sup>.

The AADs were identified using underlying cause of death according to the International Classification of Diseases and Related Health Problems (10th Revision). The AAD calculation followed the methods described by English et al.<sup>36</sup> Population attributable fraction (PAF) for each condition by age and sex was calculated using prevalence of alcohol consumption and relative risks of alcohol in causing individual conditions. Let RR<sub>ij</sub> designate the relative risks of alcohol consumption for disease j under p<sub>i</sub> the prevalence of alcohol consumption at level i. The AAD<sub>j</sub> and Alcohol-attributable YLL (AAYLL) are calculated as

$$AAD_j = D_j \cdot PAF_j,$$

and

$$AAYLL_j = YLL_j \cdot PAF_j$$

where D<sub>j</sub> and YLL<sub>j</sub> represent the total numbers of deaths and YLL respectively resulting from disease j, and PAF for disease j

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$$PAF_j = \frac{\sum_i p_i (RR_{ij} - 1)}{1 + \sum_i p_i (RR_{ij} - 1)}$$

(see e.g. reference 35). Forty-seven diseases/conditions were considered to be related to alcohol use. For most of these conditions, alcohol use was hazardous (such as road traffic accident, liver cirrhosis, oesophageal varices, epilepsy, pharynx cancer, larynx cancer, and oesophagus cancer) with the exception of five conditions, for which alcohol use may be a protective factor. They are ischemic heart disease, ischemic stroke, type 2 diabetes, hypertensive heart disease, and gallbladder disease. RRs were assumed to be identical for Indigenous and non-Indigenous deaths. The RR estimates were gathered from epidemiological reviews<sup>35–38</sup> (the RR estimates and sources are available from the authors on request). General population alcohol use prevalence estimates were derived from the 2004/5 Australian National Health Surveys<sup>9</sup>. Indigenous alcohol consumption prevalence were estimated from the 2004/5 National Aboriginal and Torres Strait Islander Health Survey<sup>8</sup>. This enabled a consistent comparison in terms of case definition and drinking prevalence grouping as both surveys applied the 2001 National Health and Medical Research Council drinking guidelines<sup>34</sup>. AADs estimates were grouped into low, risky and high-risk categories, which were defined by alcohol drinking behaviour in the week prior to interview. Rate ratio and 95% confidence interval were applied to divide Indigenous AAD and AAYLL rate by all Australian rate.

## Results

There were 529,914 deaths in Australia from 2003 to 2006, of whom 9,289 were Indigenous (Table 1). The Indigenous AAD represented 9% of the total Indigenous deaths, considerably higher than in all Australian

Table 1 Summary of numbers of deaths, AAD and years of life lost, indigenous and all Australians, Australia, 2003–2006			
	Indigenous Australians	%	All Australians
<b>Deaths</b>	9,289	1.8	529,914
<b>AAD</b>	839	7.5	11,250
<b>%</b>	9.0		2.1
<b>Years of life lost</b>	168,971	3.3	5,187,697
<b>Alcohol-attributable years of life lost</b>	18,618	7.0	265,947
<b>%</b>	11.0		5.1
<b>Average high risk drinking prevalence (%)</b>			
<b>Male</b>	10.2*		7.6 <sup>#</sup>
<b>Female</b>	5.1*		3.0 <sup>#</sup>

\* 2004–05 National Aboriginal and Torres Strait Islander health survey (prevalence weighted by population)<sup>8</sup>; <sup>#</sup> 2004–05 National health survey (prevalence weighted by population)<sup>38</sup>

population (2%). The total Indigenous AAD and AAYLL made up 7.5% and 7% of the Australian corresponding totals, disproportionate to the Indigenous population share.

Table 2 compares the most common causes of AAD between Indigenous and the general Australian population. Australian males experienced the majority of the AADs, whereas Australian females were apparently protected by alcohol consumption overall (mostly due to apparent protective effects of alcohol on ischemic heart disease and ischemic stroke). Among Indigenous males, road traffic accidents (22%), liver cirrhosis (17) and suicide (12) were the most common conditions attributable to alcohol misuse resulting in deaths, whereas for females, liver cirrhosis (29), alcohol dependence (12) and road traffic accidents (12) took the lead, all three accounting for more than half of the total AADs (Table 2). In the general population, road traffic accidents (16%), colon cancer and liver cirrhosis (11) were the top three for males, whereas for females, colon cancer (17), breast cancer (12) and liver cirrhosis (10) topped the list, accounting for

just over one-third of the total AADs. Apparent deaths averted due to alcohol were mainly due to ischemic heart disease among the Indigenous population and stroke among the general population. It is also evident that among Australian females, the number of deaths averted due to alcohol-protective effects exceeded the overall number of deaths caused. This was almost entirely among the 75+ age group and therefore, as described below, had only minor impact on AAYLL (see Table 3).

AAYLL estimates for Indigenous Australians by condition and sex are compared with those for all Australians in Table 3. A total of 265,947 AAYLLs occurred during the 4-year study period (5% of the total 5,187,697). The total AAYLL among Indigenous Australians was estimated to be 18,618 (11% of the total 168,971). The top three leading conditions with the highest AAYLLs were road traffic accidents, liver cirrhosis and suicide for both Indigenous and all Australian males. Among Indigenous females, liver cirrhosis, road traffic accident and alcohol dependence accounted for 53% of the total AAYLL, in comparison with the three

Table 2 AAD for frequently occurring alcohol related conditions by sex, indigenous and all Australians, 2003–2006

Rank	Indigenous Australians			All Australians		
	Condition	Deaths	%	Condition	Deaths	%
<b>Male</b>						
1	Road traffic accidents	156	22	Road traffic accidents	3,137	16
2	Liver cirrhosis	124	17	Colon cancer	2,225	11
3	Suicide and self-inflicted injuries	86	12	Liver cirrhosis	2,120	11
4	Alcohol dependence and harmful use	70	10	Suicide and self-inflicted injuries	1,998	10
5	Type 2 diabetes	38	5	Type 2 diabetes	1,530	8
6	Epilepsy	32	4	Oesophagus cancer	1,422	7
7	Homicide and violence	31	4	Stroke	1,157	6
8	Mouth and oropharynx cancers	27	4	Alcohol dependence and harmful use	935	5
9	Alcoholic Cardiomyopathy	26	4	Liver cancer	926	5
10	Oesophagus cancer	22	3	Mouth and oropharynx cancers	723	4
...	...			...		
46	Gall bladder and bile duct disease	-1	1	Gall bladder and bile duct disease	-60	1
47	Ischaemic heart disease	-78	99	Ischaemic heart disease	-7,093	99
<b>Deaths caused*</b>		723	3.7		19,422	100
<b>Deaths averted#</b>		-78	1.1		-7,153	100
<b>Female</b>						
1	Liver cirrhosis	68	29	Colon cancer	1,405	17
2	Alcohol dependence and harmful use	29	12	Breast cancer	1,058	12
3	Road traffic accidents	28	12	Liver cirrhosis	861	10
4	Homicide and violence	16	7	Rectal cancer	858	10
5	Suicide and self-inflicted injuries	13	5	Supraventricular cardiac dysrhythmias	543	6
6	Rectal cancer	11	4	Falls	539	6
7	Pancreatitis	10	4	Oesophagus cancer	480	6
8	Breast cancer	8	4	Suicide and self-inflicted injuries	455	5
9	Epilepsy	8	4	Road traffic accidents	445	5
10	Colon cancer	7	3	Liver cancer	384	5
...	...			...		
46	Stroke	-10	24	Ischemic heart disease	-4,096	43
47	Ischemic heart disease	-27	62	Stroke	-5,066	53
<b>Deaths caused*</b>		238	2.8		8,476	100
<b>Deaths averted#</b>		-44	0.5		-9,495	100
<b>Overall total</b>		839	7.5		11,250	100

\* conditions with relative risk &gt; 1; # conditions with relative risk &lt; 1.

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**Table 3 Alcohol-attributable years of life lost for frequently occurring alcohol related conditions by sex, Indigenous and all Australians, 2003–2006**

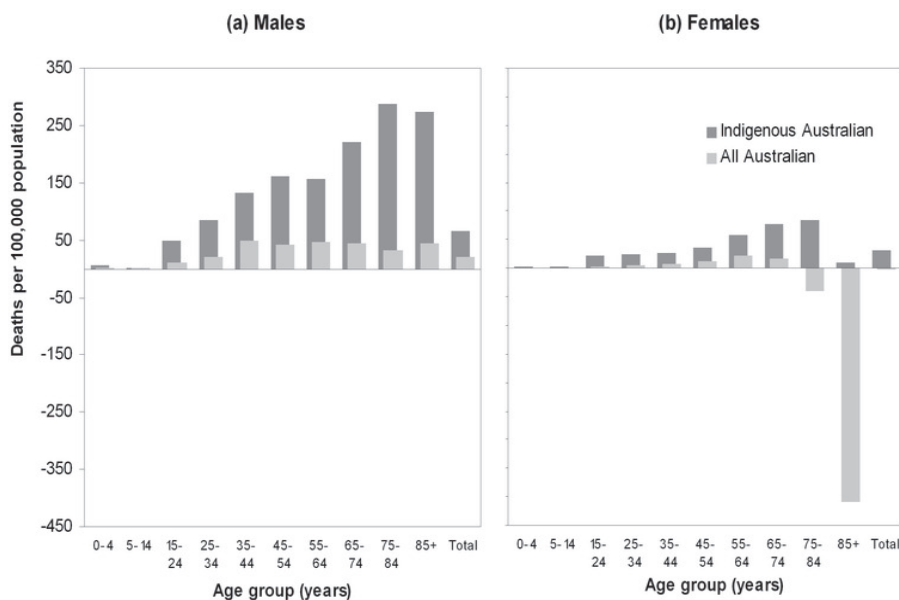
Rank	Indigenous Australians			All Australians		
	Condition	Deaths	%	Condition	Deaths	%
<b>Male</b>						
1	Road traffic accidents	3,895	25	Road traffic accidents	70,115	24
2	Liver cirrhosis	2,591	17	Suicide and self-inflicted injuries	42,521	15
3	Suicide and self-inflicted injuries	2,196	14	Liver cirrhosis	32,381	11
4	Alcohol dependence and harmful use	1,390	9	Colon cancer	24,801	9
5	Homicide and violence	768	5	Oesophagus cancer	16,764	6
6	Epilepsy	713	5	Alcohol dependence and harmful use	14,600	5
7	Type 2 diabetes	565	4	Type 2 diabetes	13,512	5
8	Alcoholic Cardiomyopathy	516	3	Liver cancer	11,521	4
9	Mouth and oropharynx cancers	488	3	Mouth and oropharynx cancers	9,836	3
10	Pancreatitis	431	3	Stroke	9,457	3
...	...			...		
46	Gall bladder and bile duct disease	-10	1	Gall bladder and bile duct disease	-487	1
47	Ischaemic heart disease	-1,403	99	Ischaemic heart disease	-64,243	99
<b>Deaths caused*</b>		15,576	5.4		288,277	100
<b>Deaths averted#</b>		-1,413	2.2		-64,730	100
<b>Female</b>						
1	Liver cirrhosis	1,476	29	Colon cancer	15,587	14
2	Road traffic accidents	711	14	Breast cancer	15,455	14
3	Alcohol dependence and harmful use	658	13	Liver cirrhosis	12,331	11
4	Homicide and violence	427	8	Suicide and self-inflicted injuries	9,912	9
5	Suicide and self-inflicted injuries	339	7	Rectal cancer	9,756	9
6	Epilepsy	192	4	Road traffic accidents	9,413	9
7	Rectal cancer	188	4	Oesophagus cancer	4,865	4
8	Pancreatitis	181	4	Liver cancer	4,519	4
9	Breast cancer	154	3	Alcohol dependence and harmful use	4,100	4
10	Mouth and oropharynx cancers	116	2	Falls	3,825	3
...	...			...		
46	Stroke	-141	21	Ischaemic heart disease	-29,451	44
47	Ischaemic heart disease	-433	64	Stroke	-35,028	52
<b>Deaths caused*</b>		5,134	4.7		109,522	100
<b>Deaths averted#</b>		-678	1.0		-67,122	100
<b>Overall total</b>		18,618	7.0		265,947	100

\* conditions with relative risk > 1; # conditions with relative risk < 1.

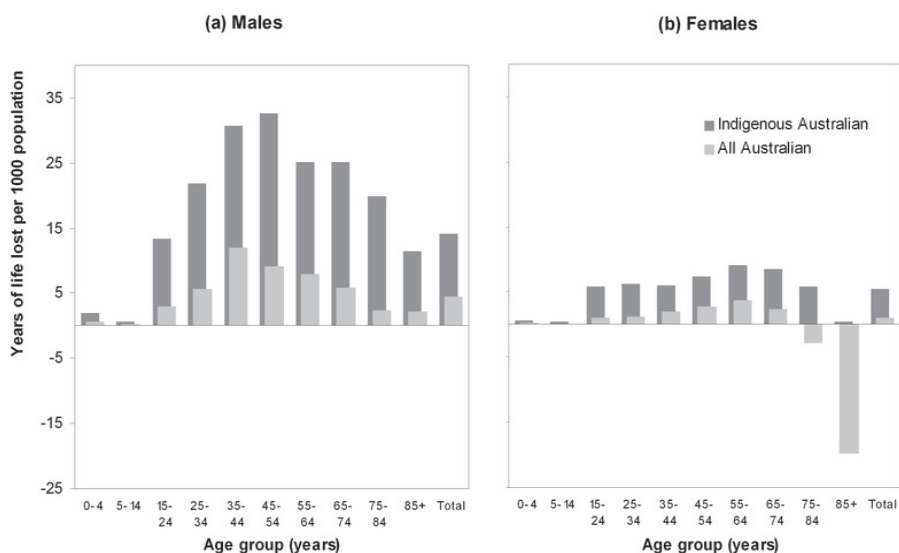
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**Figure 1:** Alcohol-attributable deaths (AAD) by age and sex, Indigenous vs. all Australians, 2003–2006 (AAD > 0 indicates deaths or lost lives due to alcohol use; AAD < 0 indicates saved lives resulting from protective effects of alcohol use)



**Figure 2:** Alcohol-attributable years of life lost (AAYLL) by age and sex, Indigenous vs. all Australians, 2003–2006 (AAYLL > 0 indicates years of life lost due to alcohol use; AAYLL < 0 indicates years of life saved resulting from protective effects of alcohol use)

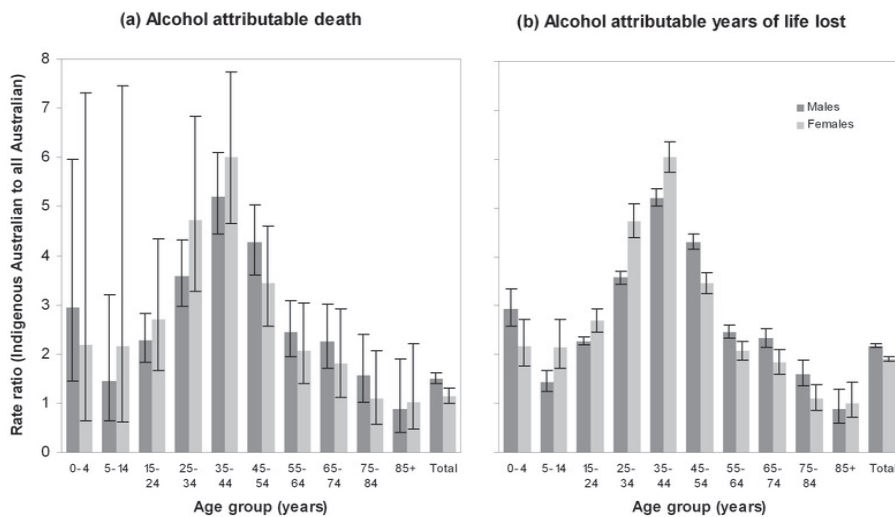
top conditions of colon cancer, breast cancer and liver cirrhosis for the general Australian female population. This result is consistent with Table 2, apart from the observation that the total AAYLL for all Australian females exceeded years of life saved. This is

because the deaths averted among females occurred largely at an elderly age, and YLL estimates applied life expectancy at the age of death and weighted deaths at younger ages over deaths at older ages (i.e. the premature loss of life for a young person

is greater than that for an older person). The high proportion of alcohol-attributable mortality among the Indigenous population appears to be the combination of higher proportionate YLL due to premature death and fewer years of life saved due to alco-protective effects, compared with the Indigenous population proportion (see bottom three lines in Tables 2 and 3).

Figures 1 and 2 depict the age distribution for AAD and AAYLL rates by sex for Indigenous Australians compared to the general Australian population. For males (panel a) and females (panel b) across all groups, both AAD and AAYLL among the Indigenous population were higher than for the general Australian population. Figure 1 shows that the divergence was particularly large for deaths occurring from 45 years onward. Notably, females in the general population experienced large apparent protective benefits attributable to alcohol after age of 75 years, while no deaths were averted among Indigenous females. Figure 2 indicates large differences in AAYLL between Indigenous and general populations across all age groups, especially ages 15–44 years.

As shown in Figure 3, the AAD (in panel a) and AAYLL (panel b) rate ratios comparing Indigenous Australians to the general population demonstrate a consistent age and sex pattern. At ages 0–4 years, AAD and AAYLL rates among the Indigenous population were 2–3 times greater than the corresponding overall population group. There was a slight drop in both AAD and AAYLL rate ratios for the 5–14 year age group. For age groups between 15 and 44 years, the AAD and AAYLL rate ratios increased with age and peaked at age 35–44 years. After age 45, both the AAD and AAYLL rate ratio decreased with age. The total AAD rate ratio was 1.50 (95% confidence interval 1.39–1.62,  $P < 0.05$ ) for males and 1.14 (1–1.3,  $P = 0.05$ )



**Figure 3:** Rate ratios and 95% confidence intervals for deaths and years of life lost due to alcohol misuse, by age group and sex, Indigenous Australians to all Australians, 2003–2006

for females. The variability in AAYLL rates was much smaller than AAD with narrower confidence intervals. The total AAYLL rate ratio was 2.18 (2.15–2.22,  $P < 0.01$ ) for males and 1.91 (1.85–1.96,  $P < 0.01$ ) for females, indicating that the alcohol-attributable mortality among the Indigenous population was about 2 times the national average. By examining the age specific rate ratio in both panels a and b, females had slightly higher rate ratio than males between ages 5 and 44 years. The sex differentials were in the opposite direction for the other age groups.

### Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Indigenous Australians constitute only 2.5% of Australia's population. However, they experience 7% to 7.5%

mortality burden resulting from alcohol consumption, on the basis of AAD and AAYLL assessments. At ages 15 to 74 years, the AAD and AAYLL rates among Indigenous Australians are 2–3 times higher than in the average Australians. At ages 25 to 54, the AAD and AAYLL rates in Indigenous Australians are 4–6 times higher than in the average Australians. AAD and AAYLL rates are substantially (2–3 times) higher in males than in females, regardless of ethnicity and age group. These results were broadly consistent with previous studies on Indigenous or general Australians (see e.g. references 17 and 39). One previous study estimated that an average of 229 Indigenous Australians died annually from harmful use of alcohol<sup>17</sup>. Our estimate (240) is slightly higher, mainly because we included deaths due to low risk category. This review provides new and more reliable national data on AAD and AAYLL comparing Indigenous Australians with the general population.

In order to understand patterns of alcohol use and harms to Indigenous people, it is necessary to examine the underlying socioeconomic determinants and to situate alcohol in an historical context. Alcohol consumption

was responsible for 9% of Indigenous deaths, compared to 2% for all Australian deaths. Significant mortality and morbidity among Indigenous Australians is associated with excess alcohol use, which generally occurs within a historical context of disadvantage. Historically, alcohol was distributed to Indigenous people in return for commercial interest and sexual favours<sup>40</sup>. Indigenous people endured violence, land dispossession, separation from own families, racial discrimination, poverty, exposure to the western lifestyle, including unhealthy food, alcohol, tobacco, and infectious diseases<sup>41</sup>. Alcohol became somewhat of a panacea for Indigenous people's pain, with many using it as a means of escape and solace<sup>42</sup>. Indigenous people drank the beverages quickly and excessively, and without food<sup>43</sup>. Hayes proposed a life cycle model to understand alcohol consumption by Indigenous Australians, from pregnancy under the influence of alcohol, to children with "an empty belly" to young adults who are angry and act out aggressively<sup>44</sup>. The Steering Committee for the Review of Government Service Provision has recognised the connection between underlying social determinants and poor Indigenous health status<sup>45</sup>. This poor health is associated with poverty, malnutrition, overcrowding, poor hygiene, environmental contamination, and prevalent infections. Inadequate clinical care and poor disease prevention aggravate this situation. Some Indigenous groups, as they move from traditional to transitional and modern lifestyles, are rapidly acquiring lifestyle diseases, such as obesity, cardiovascular disease, type 2 diabetes, and physical, social, and mental disorders linked to misuse of alcohol and other drugs<sup>41</sup>. Poverty can explain between one-third and one-half of the life expectancy gap and outweighs the other behaviour risk factors including alcohol abuse (1–7%)<sup>46</sup>.

Efforts to close the Indigenous health gap will be more effective and enduring if they address the socioeconomic circumstances of Indigenous people. Conversely, the failure to address poverty in Indigenous communities is likely to undermine gains that might otherwise occur through traditional prevention activities, such as alcohol and obesity control campaigns and alcohol restrictions. Although alcohol restrictions (including price controls and restrictions on access) have been found to be effective at reducing alcohol consumption and harms in many Indigenous communities, efforts to control substance abuse in remote communities may be best addressed in the context of understanding the dynamics of alcohol and drug use in totality as well as interventions that address underlying structural and social inequalities<sup>47</sup>.

Alcohol misuse often occurs in combination with other health risks. Information on patient risk factors (overweight/obesity, daily smoking and at-risk alcohol consumption) is collected from primary care encounter data. The majority (73%) of patients had multiple risk factors including smoking (51), harmful alcohol consumption (10) and obese body mass index (49)<sup>48</sup>. Strategies targeting wide range of risk factors need to be employed to reduce the excess mortality in the Indigenous population. There is no quick and single solution to this complex issue of alcohol misuse. Interventions may range from social policy, public health, primary care, to secondary prevention and tertiary care<sup>49-52</sup>.

There were a number of limitations to this review. The RRs which underlie the alcohol aetiological fractions estimates, were derived from the international literature and this literature is dominated by studies conducted on predominantly white, developed nations. There is a paucity of studies, which would enable Indigenous-specific RRs for alcohol-related conditions to be derived

(i.e. case control and cohort studies of alcohol-related diseases). It was plausible to estimate attributable fractions specific to the Indigenous population<sup>53</sup>. For a small proportion (1.5%) of deaths, Indigenous status was unknown. All the deaths with unknown Indigenous status were assigned to the non-Indigenous category. Although the effect on the estimate is likely to be small, this would also tend any bias towards under-estimation for the Indigenous population. Unfortunately, we did not have access to the national death data beyond 2008 as the ABS has ceased all data release while it reviews its policy on use of death records for research purposes. We also note that this analysis is based on year of death rather than year of death registration. Therefore, late registrations of deaths due to alcohol-attributable conditions after 1 January 2008 were not included in the analysis. Previous analyses indicate that over 95% of deaths are registered within 12 months after death and we therefore estimate that any under-reporting would be minimal. It is also possible that in rural areas, a larger proportion of deaths, which are actually due to alcohol-related conditions, could be misidentified. In addition, research showed that melioidosis, sexually transmitted diseases, and mental health conditions are associated with alcohol abuse but not included in our estimates<sup>20,21,28</sup>. However, the fatal health outcomes of these conditions are believed to be minimal<sup>35</sup>. Due to the nature of this review, the results need to be interpreted with caution. The review does not assess causal relationships and other risk factors may have also contributed to the higher mortality rate. The review has not adjusted for the contribution of other risk factors. Further studies that focus on the co-effects of the multiple risk factors are warranted, especially for Indigenous populations.

## Conclusion

The harmful use of alcohol contributes to a disproportionate mortality burden experienced by Indigenous Australians. Improving socioeconomic status and enhancing alcohol interventions using culturally appropriate and multidisciplinary approaches are likely to be key to mitigating alcohol-fuelled diseases and injuries among Indigenous Australians.

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