Estimated alcohol-attributable health burden in Aotearoa New Zealand

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Conflict of interest statement

Dr Jones' involvement in this project predated her employment at Te Hiringa Hauora. The authors have no other conflict of interests to declare. No authors have received funding from the alcohol industry.

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Table of Contents

Table of Tables

Table of Figures

Supplementary material description

Table 1. Overview of supplementary material included in this report

Title	Description
SM1: Alcohol-attributable fractions - user guide	This file contains all the Aotearoa New Zealand specific alcohol-attributable fractions (AAFs) with 95% Uncertainty Intervals (UI) for each disease and injury condition (n = 26) and age-sex-ethnicity subgroup (n = 28) (sheet = 'AAFs') and associated data dictionary (sheet = 'Cover sheet'). The file also contains a user guide that outlines some of the key assumptions that require consideration by those wanting to apply the AAFs to local data (sheet = 'User guide').
SM2: Supplementary methods	This file contains additional methodological detail. Primarily the information contained in this file relates to the processing of outcome data; mapping outcome data to ICD codes; methods for age and sex standardisation; and the calculation of alcohol use for the 2018 Aotearoa New Zealand population.
SM3: Supplementary results	This file contains the alcohol-attributable deaths, cancer registrations, publicly funded hospitalisations, Accident Compensation Corporation injury claims (ACC) and disability adjusted life years (DALYs) for every disease and injury condition and each age-sex-ethnicity subgroup. These results can be re-analysed by any end/next user to conduct further analyses above and beyond what is presented in this report and supplementary results. The file also contains six additional results tables. For three outcomes (deaths, cancer registrations and hospitalisations), there are two tables that outline 1) the total and alcohol-attributable counts for that outcome for all relevant disease and injury conditions as well as the percentage of that outcome that is alcohol-attributable; and 2) the original and age-sex standardised rates for alcohol-attributable conditions by ethnicity (Māori/Non-Māori).

Executive summary

INTRODUCTION

Alcohol is a component cause for numerous disease and injury conditions. This report provides an updated estimate for alcohol-attributable morbidity and mortality for Māori, non-Māori, and the overall Aotearoa New Zealand population in 2018. One approach to quantifying the wide-ranging health harms of alcohol is the use of attributable fractions, which estimate the proportion of a disease or condition in a population that is associated with a particular risk factor (e.g. alcohol). The estimates reflect currently available risk quantifications on the health impacts of alcohol consumption and Aotearoa New Zealand alcohol consumption patterns. The estimates also lay the groundwork for the future monitoring of alcohol harms in the Māori and non-Māori population. Specifically, this report addresses the following research questions:

1. What is the alcohol-attributable morbidity and mortality as measured by deaths, cancer registrations, hospitalisations, Accident Compensation Corporation (ACC) injury claims and disability-adjusted life years (DALYs)?
2. What are the differences in alcohol-attributable morbidity and mortality in Māori and non-Māori?

METHODS

This project used a comparative risk assessment methodology to estimate the health loss due to alcohol consumption in Aotearoa New Zealand in 2018 for ages >14 years. We used national-level data on alcohol consumption and health loss measures drawn from a variety of sources including the Manatū Hauora | Ministry of Health, Statistics New Zealand (Stats NZ), ACC and the Global Burden of Disease Study (GBD). We calculated estimates for Māori and non-Māori, by sex and by age group. We used the International Model of Alcohol Harms and Policies (InterMAHP), an open access alcohol harms and policy scenario model developed by the University of Victoria (Canada) to calculate Aotearoa New Zealand-specific alcohol-attributable fractions (AAF) for 26 disease and injury conditions. We applied the relevant disease and injury AAFs to our measures of health loss (deaths, cancer registrations, publicly funded hospitalisations, ACC injury claims, DALYs) to estimate the burden of disease associated with alcohol use. The results presented are the net outcomes (assume a reduced risk for three conditions at low levels of consumption) unless specified as the gross outcomes (assumes there is no reduced risk for those three conditions).

RESULTS

Table 2 provides a summary of the alcohol-attributable health burden in Aotearoa New Zealand in 2018. In total, alcohol was attributable for an estimated 901 deaths (95%uncertainty interval (UI) 681 - 1,104), 1,250 cancers (95%UI 1,084 − 1,383), 29,282 hospitalisations (95%UI 25,713 − 32,318), 49,742 DALYs (95%UI 42,988 -55,518) and 128,963 ACC claims (95%UI 114,324 – 140,681) in 2018. The alcohol-attributable burden for Māori included 173 deaths, 148 cancers, 5,210 hospitalisations and 16,078 ACC claims. The age and sex standardised rate of alcohol-attributable mortality was twice as high for Māori (309 per 100,000 people) than for non-Māori.

Males accounted for the majority of health harms with 753 deaths (83% of all alcohol-attributable deaths), 589 cancers (47% of all alcohol-attributable cancers), 18,779 hospitalisations (64% of all alcohol-attributable publicly funded hospitalisations), 37,738 DALYs (76% of all alcohol-attributable DALYs) and 81,102 ACC claims (63% of all alcohol-attributable ACC claims). Alcohol-attributable cancers contributed the highest number of deaths of any condition group with 376 deaths (42% of all alcohol-attributable deaths), the third highest number of hospitalisations at 1,580 (5%) and the third highest DALYs at 10,227 (21%).

Injuries accounted for the second highest number of deaths at 296 (33% of all alcohol-attributable deaths), the highest number of hospitalisations at 12,766 (44% of all alcohol-attributable hospitalisations) and second most DALYs 17,962 (36% of all alcohol-attributable DALYs). The 'Other' category of conditions (i.e. alcohol use disorders, alcohol gastritis, epilepsy, liver cirrhosis, pancreatitis) contributed the third highest mortality with 220 deaths (25% of all alcohol-attributable deaths), second highest number of hospitalisations at 11,764 (34% of all alcohol-attributable hospitalisations) and the most DALYs at 22,150 (45% of all alcohol-attributable DALYs).

CONCLUSIONS

Alcohol causes a substantial preventable health burden via a range of disease and injury conditions. The health burden from alcohol is disproportionately borne by Māori and males. Cancers, injuries and conditions that are wholly attributable to alcohol use (e.g. alcoholic gastritis and alcohol use disorders – contained in the 'other' category) contribute the majority of alcohol-attributable mortality and morbidity. Our estimates are conservative for a number of reasons, including: 1) they assume there are potential protective effects of low-level consumption, for which the evidence is heavily contested; 2) our inability to include the full range of alcohol-attributable conditions (e.g. fetal alcohol spectrum disorder); 3) our inability to include other measures of health loss such as utilisation of secondary and community mental health and addiction treatments; 4) the GBD's relative risk functions used in this analysis produce estimates ~25% lower than studies using the World Health Organisation's relative risks.

In addition to the health burden, these alcohol-attributable heath impacts also place a substantial economic burden on individuals and the Government. Given the current policy landscape in Aotearoa New Zealand and international best practice, the most effective policy avenues for reducing the alcohol-attributable health burden are restrictions on alcohol marketing and availability, increases to excise tax, and implementation of a national screening and brief intervention programme.

Table 2. Summary of estimated alcohol-attributable deaths, cancer registrations, publicly funded hospitalisations, disability-adjusted life years and Accident Compensation Corporation injury claims in 2018 by demographic group (top panel), condition group (middle panel) and gross outcomes (bottom panel)

Demographic group		Deaths n (95%UI)	Cancers n (95%UI)	Hospitalisations n (95%UI)	DALYs* n (95%UI)	ACC injury claims** n (95%UI)
All		901 (681 – 1,104)	1,250 (1,084 – 1,383)	29,282 (25,713 – 32,318)	49,742 (42,988 – 55,518)	128,963 (114,324 – 140,681)
Māori	Female	31 (24 – 39)	87 (75 – 96)	1,972 (1,733 – 2,190)		5,820 (5,082 – 6,447)
	Male	142 (123 – 157)	61 (54 – 65)	3,238 (2,896 – 3,494)		10,258 (9,223 – 11,020)
Non-Māori	Female	117 (45 – 195)	574 (488 – 648)	8,530 (7,416 – 9,627)		42,041 (36,360 – 47,033)
	Male	611 (490 – 713)	529 (467 – 573)	15,541 (13,667 – 17,006)		70,844 (63,659 – 76,180)
Age group	15-34	99 (85 – 110)	17 (15 – 20)	7,537 (6,854 – 8,123)	11,910 (10,978 – 12,685)	41,198 (36,163 – 45,349)
	35-64	422 (365 – 467)	642 (566 – 700)	13,334 (11,946 – 14,432)	27,433 (24,598 – 29,646)	64,260 (57,387 – 69,593)
	65+	380 (231 – 526)	590 (503 – 663)	8,411 (6,913 – 9,763)	10,399 (7,412 – 13,187)	23,505 (20,774 – 25,738)
Condition group		**Deaths** n (95%UI)	**Cancers** n (95%UI)	**Hospitalisations** n (95%UI)	**DALYs*** n (95%UI)	**ACC injury claims**** n (95%UI)
All		901 (681 – 1,104)	1,250 (1,084 – 1,383)	29,282 (25,713 – 32,318)	49,742 (42,988 – 55,518)	128,963 (114,324 – 140,681)
Injuries		296 (257 – 328)		12,766 (11,190 – 14,055)	17,962 (15,720 – 19,736)	128,963 (114,324 – 140,681)
Cardiovascular conditions		21 (-65 – 114)		1,707 (931 – 2,421)	556 (-1,441 – 2,510)	
Diabetes		-52 (-59 – -44)		-309 (-357 – -257)	-1,814 (-2,076 – -1,529)	
Cancers		376 (323 – 420)	1,250 (1,084 – 1,383)	1,580 (1,373 – 1,744)	10,227 (8,867 – 11,307)	
Communicable diseases		39 (27 – 50)		1,773 (1,290 – 2,221)	661 (494 – 818)	
Other***		220 (199 – 236)		11,764 (11,287 – 12,135)	22,150 (21,424 – 22,676)	
Gross outcomes**		**Deaths** n (95%UI)	**Cancers** n (95%UI)	**Hospitalisations** n (95%UI)	**DALYs*** n (95%UI)	**ACC injury claims**** n (95%UI)
All		1,379 (1,202 – 1,528)	1,250 (1,084 – 1,383)	31,484 (28,209 – 34,204)	58,927 (53,127 – 63,597)	128,963 (114,324 – 140,681)

* DALYs by ethnicity were not available from the Global Burden of Disease Study; ** All included claims (89% of all ACC injury claims were included in the dataset provided by ACC); *** 'Other' includes alcohol use disorders, alcoholic gastritis, epilepsy, liver cirrhosis, pancreatitis; **** Assumes no potential protective effect of lower consumption for ischaemic heart disease or diabetes.

Introduction

Alcohol is a component cause for numerous disease and injury conditions.[1] Alcohol use is associated with cardiovascular disease, including ischaemic heart disease, hypertensive heart disease, atrial fibrillation and flutter, cardiomyopathies, and stroke.[1] Alcohol is also classified as a Group 1 carcinogen[2] and is causally associated with numerous types of cancer including: pharyngeal, laryngeal, oesophageal, colorectal, liver and breast.[1] Alcohol contributes to intentional and unintentional injuries, poor mental health[3] and fetal alcohol spectrum disorder (FASD).[4]

This report provides new estimates for alcohol-attributable morbidity and mortality for Māori, non-Māori, and the overall Aotearoa New Zealand population >14 years of age in 2018. The methods are not directly comparable with previous reports. The estimates reflect currently available risk quantifications on the relationship between alcohol consumption and health impacts as well as the latest estimates of Aotearoa New Zealand alcohol consumption patterns. The report lays the groundwork for the future monitoring of alcohol harms in the Māori and non-Māori population. Specifically, this report addressed the following research questions:

1. What is the alcohol-attributable morbidity and mortality as measured by deaths, cancer registrations, publicly funded hospitalisations, Accident Compensation Corporation (ACC) injury claims and disability-adjusted life years (DALYs)?
2. What are the differences in alcohol-attributable morbidity and mortality in Māori and non-Māori?

Quantifying the health burden using alcohol-attributable fractions

An attributable fraction is the estimated proportion of a disease or condition in a population that is associated with a particular risk factor.[5] In this context, an alcohol-attributable fraction (AAF) is the proportion of a disease or condition in a population that is associated with that population's alcohol consumption (more methodological detail on AAFs is provided in the Methods). Numerous studies have used AAFs to estimate the alcohol-attributable health burden in the United States,[6-9] Canada,[10] Switzerland,[11] France,[12] Finland,[12] Germany,[13,14] the United Kingdom,[13,14] Denmark,[13,14] Italy,[13,14] Ireland[15] and globally.[16]

In Aotearoa New Zealand, the Alcohol Advisory Council of New Zealand published the nation's first comprehensive estimate of the burden of morbidity and mortality associated with alcohol consumption for 2000/2002.[17] The report estimated that around 4% of all deaths in Aotearoa New Zealand in 2000 were attributable to alcohol consumption (approximately 1,040 deaths, with 17,200 years of life lost [YLLs]).[17] Overall, alcohol-attributable mortality was four times higher for Māori than for non-Māori.[17] In 2013, Te Hiringa Hauora | Health Promotion Agency published an updated report, which provided revised Aotearoa New Zealand estimates of death and disability due to alcohol consumption for 2004/2007.[17] It was estimated that 5.4% of all deaths in those under 80 years of age were attributable to alcohol consumption (802 deaths and 13,769 YLLs).[17] The age-standardised rates of alcohol-attributable mortality and YLLs for Māori were almost two times higher than the corresponding rates for non-Māori.[17]

Alcohol's historical context in Aotearoa New Zealand

Alcohol-related harm among Māori in Aotearoa New Zealand is linked to the experience of colonisation. Alcohol was first introduced by European settlers, and early settlers reported that some Māori had a strong aversion to it at the time.[18] However, alcohol became socially accepted by many Māori communities and was often used by Pākehā settlers as a tool to convince Māori to sell their land.[19] There is evidence that the colonial government was aware of the correlation between alcohol and the disempowerment of Māori.[19]

A number of 19th century Māori leaders were also aware of the relationship between alcohol and Māori alienation from the land, and were vocal in their disapproval of alcohol use in Māori communities.[20] Throughout the 1800s, Māori attempted to regulate alcohol use in their communities and efforts included petitioning the government, campaigning for control of alcohol sales within their rohe, and banning alcohol on certain marae and in certain Māori communities.[18,19] However, during this time, the government undermined Māori self-determination and their ability to regulate alcohol use within their own communities by prohibiting the sale of alcohol to Māori.[18,19] This may have prevented Māori from developing their own mechanisms to manage the consequences of alcohol use in their communities.[18] Currently, a Waitangi Tribunal claim alleges that the Sale and Supply of Alcohol Act (SSAA) is failing to reduce alcohol harms in Māori communities.[21] Additionally, the claim contends that the Crown has failed to work in partnership with Māori communities, develop policies and services that address the underlying causes of alcohol use, and recognise te ao Māori as part of service provision.[22]

The introduction of alcohol to Pacific peoples was also linked to the experience of colonisation and migration.[23] Alcohol consumption was not a part of traditional Pacific culture and was likely introduced through contact with European sailors, whalers, and traders in the early 19th century.[23,24] After migrations to Aotearoa New Zealand from the late 1950s, Pacific communities' alcohol consumption slowly began to shift, with heavy drinking becoming more common,[24] although alcohol use may vary between the different Pacific ethnic groups.[23] The prevalence of current drinkers is lower in Pacific peoples than in non-Pacific people in Aotearoa New Zealand,[23] however, those who do drink are more likely to be hazardous drinkers than non-Pacific, non-Māori drinkers.[23] There is evidence that certain aspects of traditional Pacific culture (e.g. spirituality, religion, or attending a place of worship regularly; or fluency in a Pacific language) may be protective against hazardous drinking.[23]

Alcohol consumption in Aotearoa New Zealand

In Aotearoa New Zealand, the proportion of the population who are hazardous drinkers has remained unchanged at around 20% since 2015/2016.[25] In 2020/2021, men were more likely than women (adjusted ratio 1.97, 95% confidence interval (CI) 1.66, 2.34) and Māori more likely than non-Māori (adjusted ratio 1.89, 95%CI 1.59 - 2,24) to be hazardous drinkers.[26] Likewise, among drinkers, Pacific peoples were more likely to be hazardous drinkers than non-Pacific (adjusted ratio 1.56, 95%CI 1.21 - 2.03).[26] However, the use of the term hazardous drinking implies that alcohol use for drinkers below this threshold may not be harmful, which is incorrect. The World Health Organization (WHO) defines the 'harmful use of alcohol' as drinking that causes detrimental health

and social consequences for the drinker, the people around the drinker and society at large.[27] In 2023, the WHO stated that there is no safe amount of alcohol consumption that does not impact health.[28] Further, they clarified that there is no evidence of a threshold at which the carcinogenic effects of alcohol are triggered.[28] For example, an estimated 13.3% of all alcohol-related cancers in Europe (23,000 cancer cases) occur among people with consumption below low-risk drinking guidelines each year.[29]

The current Manatū Hauora low-risk drinking guidelines (developed in 2011) state that to reduce long-term health risks, women should drink no more than ten standard drinks a week and men no more than 15.[30] A national survey of compliance with the Manatū Hauora low-risk drinking guidelines in 2018 found that 53% of men and 45% of women consumed more than the recommended daily limit, while 25% of men and 19% of women consumed more than the recommended weekly limit.[31] Alcohol consumption estimates from a 2023 Aotearoa New Zealand modelling study suggest current adherence to the low-risk drinking guidelines is likely lower than estimated in this national survey.[32]

In response to greater evidence of health burden at lower levels of consumption, jurisdictions have revised their low-risk drinking guidelines. Australia updated its low-risk drinking guidelines in 2020 to no more than 10 standard drinks per week for both men and women. Following a sensitivity analysis that excluded the contested evidence of potential protective effects of alcohol consumption at lower levels, the guideline level was reduced to ~2.5 drinks per week (see Table A2.2).[33] In 2023, the Canadian Centre on Substance Use and Addiction issued its Guidance on Alcohol and Health, which included an advisory that any more than two standard drinks per week will increase your risk of developing several types of cancer, including breast and colon cancer.[34] Further, this guidance stated that each additional standard drink radically increases the risk of alcohol-related consequences.[34] The Canadian Centre on Substance Use and Addiction updated meta-analysis on the health impacts of alcohol consumption observed no statistically significant protective effect of lower levels of alcohol use for ischaemic heart disease and intracerebral haemorrhage (see Appendix 2 from Paradis, et al. (2023)[34]).

Alcohol policy in Aotearoa New Zealand

The WHO's SAFER initiative, launched in 2018, identifies highly effective strategies for governments to adopt.[35] Below we discuss Aotearoa New Zealand current policy settings to reduce alcohol-related harm in context of the WHO SAFER framework.

Strengthen restrictions on alcohol availability. Alcohol availability relates to the ease of obtaining alcohol.[36] In Aotearoa New Zealand, alcohol availability is primarily regulated via the SSAA, which has national limits for outlet operating hours and established the regulatory framework for licensing decisions. A recent analysis found the SSAA has not resulted in any substantial changes to alcohol trading hours or outlet density.[37] The SSAA enables local authorities to establish their own policies related to some aspects of alcohol availability via Local Alcohol Policies (LAPs). Many LAPs have been challenged in court by the alcohol industry, which has halted their implementation or weakened their alcohol control measures.[38,39] Currently, trading hours for off-licences are from 7am to 11pm resulting in a national maximum of 112 hours per week, while current outlet density

estimates are around 63 off-licences per 100,000 people.[32] This level of alcohol availability is substantially higher than in other countries such as Finland or Sweden (~50 hours per week and five outlets per 100,000). In Aotearoa New Zealand, there are also stark inequities in alcohol availability by deprivation and ethnicity. For example, the off-licence outlet density is three times higher in areas of high deprivation (94.6 per 100,000 people) compared to areas of low deprivation (31.0 per 100,000 people).[32] Communities with a higher proportion of Māori also have relatively higher off-licence density, with 74.5 alcohol outlets per 100,000 people compared to 56.4 per 100,000 people for communities with a high proportion of non-Māori.[32] A 2023 modelling study estimated that stricter limits on off-licence outlet operating hours (reduced to 50 hours per week) and density (reduced to 5 outlets per 100,000 people) could reduce overall alcohol consumption in Aotearoa New Zealand by 17.9% and result in 450,000 health-adjusted life years (HALYs) gained over the lifetime of the 2018 population.[32]

Advance and enforce drink driving counter-measures. Drink driving counter-measures are largely regulated by the Land Transport Act 1998 which sets the breath and blood alcohol limits as well as the penalties for exceeding them.[40] For drivers aged under 20, there is a zero-alcohol limit, while drivers 20 and over start to incur penalties at >50 mg/dl of blood, which increase at >80 mg/dl. Two major changes to the limits occurred recently: in 2011 the zero limit for under 20s was brought in, while in 2014 the limit for 20 and over drivers was reduced from 80 mg/dl to 50 mg/dl.[41] The standard of 50 mg/dl is in line with WHO best practice and has been adopted by other comparable countries including Australia, Denmark, Finland, Scotland and Ireland.[41] Despite these changes and best international practice, the proportion of all deaths and serious road traffic injuries involving alcohol has remained between 11% and 18% year-on-year since 2008.[41]

Another important policy target set is the number of tests via random breath testing (RBT) conducted by police each year. The number of RBTs has decreased from 0.7 tests per capita in 2009 to 0.3 tests per capita in 2021.[41] As well as capacity constraints, decreased number of breath tests has been attributable to a strategic shift to high-risk testing (e.g. more testing Saturday night, Sunday morning and after big events).

Facilitate access to screening, brief interventions and treatment. Brief interventions usually consist of short (one to four sessions) or as little as three to five minutes of simple advice from a health professional to an individual about reducing their alcohol intake.[42] A 2018 Cochrane systematic review and meta-analysis of 34 randomised controlled trials of brief interventions in primary care found that alcohol average consumption among those receiving the intervention was -20 g per week (95%CI -28 - -12) one year after receiving the intervention compared to those that received limited or no intervention.[43] Brief interventions can also be cost-effective with United Kingdom (UK)[44] and A-NZ[42] economic analyses suggesting a 2- to 12-fold return on investment, which is supported by the Cochrane review of empirical studies.[43]

In 2010, the Law Commission recommended developing a national primary care programme of screening, brief interventions and referral to specialist treatment.[45] At least two brief intervention feasibility studies have been conducted in the Aotearoa New Zealand context which showed that

screening and brief intervention was feasible with additional resource.[46,47] However, to date, there has been no implementation of a systematic or mandated national alcohol screening programme.

Enforce bans or comprehensive restrictions on alcohol advertising, sponsorship and promotion. In Aotearoa New Zealand, alcohol marketing is governed by codes developed, monitored and enforced by the advertising industry, via the Advertising Standards Authority (ASA).[48] The effectiveness of self-regulatory codes globally was investigated in a recent systematic review which concluded that "self-regulatory systems that govern alcohol marketing practices are not meeting their intended goal of protecting vulnerable populations." [49, p.45] This conclusion holds true in Aotearoa New Zealand with children exposed to alcohol marketing via a range of different media on average 4.5 times per day.[50-52] Alcohol marketing also disproportionately affects Māori and Pacific children compared to non-Māori, non-Pacific children.[51] Three separate government-initiated reviews over the last two decades have recommended implementing a legislative framework for alcohol marketing due to the limitations of the self-regulation.[45,53,54] Globally, alcohol marketing restrictions have been estimated to reduce alcohol consumption by up to 8% at the population-level depending on the stringency of the restrictions.[55-60] In Aotearoa New Zealand, a modelled study estimated such a reduction could result in an additional 226,000 HALYs gained.[32]

Raise prices on alcohol through excise tax and pricing policies. The price of alcohol in Aotearoa New Zealand is primarily regulated via an alcohol excise tax. In the 2022/2023 financial year, customs received $1.29bn in excise tax from alcohol.[61] Alcohol excise tax makes up between 20-50% of the product price depending on the type of alcoholic drink.[62] There is also a small levy imposed on alcohol producers to cover the costs of alcohol-harm reduction activities at Manatū Hauora (previously Te Hiringa Hauora).[63] In contrast to the excise tax, the levy is ~$12m each year (i.e. < 1% of the size of the excise tax), so the levy is unlikely to substantially impact the price of alcohol (contributing between 0.2-1.3% of the price across different alcoholic beverages).[62]

The excise tax is adjusted each year in line with the consumer price index (CPI). However, outside these CPI increases there has not been any increase to the excise tax.[62] The 2010 Law Commission recommended raising alcohol excise tax by at least 50%, which was not implemented.[45] In 2014, Tāhū o te Ture | Ministry of Justice modelled the impact of tax increases between 82% to 133%.[64] The smallest of these increases (82%) was estimated to reduce alcohol consumption by 12.2% and result in net savings to society of $339m in the first year and $2,452m over ten years.[64] Aotearoa New Zealand modelling in 2023 estimated that excise tax increases of between 82-133% could result in between 305,000 to 482,000 HALYs gained for the 2018 population over their lifetime.[32]

There are also a number of features of the excise tax system that have led to some products being taxed inconsistently. For example, wine is taxed at a flat rate of 10% alcohol by volume (ABV) which essentially means for a commonly produced 12.5% ABV strength wine, a fifth of the bottle was produced effectively tax-free.[63] Second, beverages between 6-14% are taxed by beverage volume bands and ABV, which effectively means two 500 mL beverages with 6% and 12% ABV pay the same

excise tax despite one containing twice the alcohol. Such an anomaly incentivises production of products towards the higher end of this range (6-14%).[63] In 2019, the Government-initiated Tax Working Group recommended "the Government review the rate structure of alcohol excise with the intention of rationalising and simplifying it."[65, p.22] Another Aotearoa New Zealand modelled study estimated that aligning our excise tax system with the UK and Australia could reduce alcohol consumption by 4.3%.[66]

Te Tiriti o Waitangi is a key constitutional document of Aotearoa New Zealand and regarded as a founding document of the Government of New Zealand.[67] Te Tiriti also provides an opportunity to address the unequivocal disproportionate alcohol-related harms experienced by Māori, while also improving alcohol legislation to improve the health of the overall Aotearoa New Zealand population. However, to date, Te Tiriti is not meaningfully integrated into any of the key alcohol legislation outlined above,[67] which perpetuates inequities in alcohol-related harm for Māori. At the least, it has been suggested that Te Tiriti-based alcohol legislation would empower Māori to meaningfully and effectively participate in decisions about alcohol in their communities and enable the achievement of equitable health and social outcomes for Māori.[67] Maynard (2022)[67] provides practical suggestions to ensure alcohol legislation is Te Tiriti-consistent, which includes Te Tiriti statements upfront and throughout legislation, for example, including a statement establishing that all persons with powers under the legislation must give effect to Te Tiriti.

The current study

The current study provides a new estimate of the alcohol-attributable health burden for Aotearoa New Zealand that provides an update on previous Aotearoa New Zealand estimates (2000-2002 and 2004-2007).[17,68] The current study used updated: alcohol consumption figures (2018); relative risk estimates for 26 alcohol-attributable disease and injury conditions (produced in 2016); and outcomes of mortality and morbidity (2018 deaths, cancer registrations, hospitalisations, ACC injury claims and DALYs). This updated estimate on the extent of the health harms attributable to alcohol is important for policy development and identifying and addressing health inequities. While there are similarities between the methodological approaches used in this current study and previous Aotearoa New Zealand studies, it should be noted that direct comparability between AAF studies is challenging due to key methodological differences (e.g. calculating alcohol use in Aotearoa New Zealand) and evidence developments (e.g. changes to relative risk estimates). Thus, any differences in the health harm estimates produced by these studies should be interpreted cautiously and do not necessarily reflect a change in alcohol-attributable health harms over time (increasing or decreasing). Where appropriate and feasible, we have attempted to outline the key methodological differences between this current study and the two previous Aotearoa New Zealand AAF studies in the methods section, supplementary methods (SM2) and discussion.

Methods

Study design

This project used a comparative risk assessment methodology to estimate the health loss due to alcohol consumption in Aotearoa New Zealand in 2018 for Māori and non-Māori, by sex and age group.

International Model of Alcohol Harms and Policies (InterMAHP)

We used the International Model of Alcohol Harms and Policies (InterMAHP, version 3.0), an open access alcohol harms and policy scenario model developed by researchers at the Canadian Institute for Substance Use Research at the University of Victoria Canada, along with several other experts.[69,70] InterMAHP incorporates up-to-date research literature on the risk relationship between alcohol consumption and diseases and injuries towards the goal of providing international standardisation in the estimation of alcohol-attributable health harms. InterMAHP has been used to estimate the alcohol-caused burden of disease in projects in Canada,[71,72] the United States,[73] Finland,[74] Sweden[59] and Australia.[75] The model combines population-level alcohol consumption data with published risk relationships between alcohol use and specific health conditions to quantify AAFs – the proportion of each condition that can be attributed to alcohol use. We applied relevant AAFs to enumerated measures of health loss (counts of deaths, cancer registrations, publicly funded hospitalisations, ACC injury claims, DALYs) to estimate the health lost due to alcohol use. Our analysis included 26 health conditions associated with individuals' alcohol use (see Table 3).

Briefly, InterMAHP automates the estimation of AAFs by integrating, by population subgroup, a Gamma distribution-based[76] continuous prevalence distribution of daily alcohol use against relative risk functions identified for each health condition, as described in more detail in the publication set formalising the InterMAHP methodology.[70,77,78] Our analysis does not capture health loss where the person harmed and consumer are different individuals (e.g. an individual with FASD). While InterMAHP has the functionality to adjust for binge drinking or former drinkers, the GBD relative risks used in this current study do not. Consequently, any independent risks associated with binge drinking or being a former drinker were not incorporated into the AAF estimation for this current study, which is outlined in more detail in the limitations section of this report. An overview of data sources and methods used for the analysis is given below with more details included in the supplementary methods (SM2).

Table 3. Alcohol-attributable conditions by condition category

Condition group	Conditions
Injuries	Interpersonal violence, self-harm, transport injuries, unintentional injuries.
Cardiovascular conditions	Alcoholic cardiomyopathy, atrial fibrillation and cardiac arrhythmia, haemorrhagic stroke, hypertension, ischaemic heart disease, ischaemic stroke.
Diabetes	Diabetes.

Condition group	Conditions
Cancers	Breast cancer, colorectal cancer, laryngeal cancer, lip and oral cavity cancer, liver cancer, nasopharyngeal cancer, oesophageal cancer, pharyngeal cancer.
Communicable diseases	Lower respiratory tract infections, tuberculosis.
Other	Alcohol use disorders, alcoholic gastritis, epilepsy, liver cirrhosis, pancreatitis.

Data sources

We used national-level data on alcohol consumption and health loss measures drawn from a variety of sources including the Manatū Hauora, Stats NZ, and the Global Burden of Disease Study (GBD) for the analysis (see Table 4).

Alcohol use

Our analysis combined multiple data sources to calculate per capita alcohol consumption for the Aotearoa New Zealand population. We calculated per capita consumption from self-reported alcohol use in the New Zealand Health Survey 2018/19, per capita alcohol available for consumption from Stats NZ and Aotearoa New Zealand specific estimates of unrecorded and tourist alcohol consumption from the WHO Global Information System on Alcohol and Health (GISAH). Per capita alcohol consumption inputs used in InterMAHP were disaggregated by sex, age group, and (prioritised) ethnicity (Māori/non-Māori). For a comprehensive overview of the calculation and values for alcohol consumption used in this study see the supplementary methods (SM2).

Health loss

We applied the AAFs to five measures of health loss: deaths, cancer registrations, publicly funded hospitalisations, ACC injury claims and DALYs. For each measure of health loss, we obtained condition-level data by age, sex, and ethnicity where available.

Table 4. List of data sources used for analysis

Data	Description	Measures	Disaggregation
New Zealand Health Survey 2018/19.	Population-based survey. Nationally representative (15 years and older). Data collection from 1 July 2018 to 30 June 2019 via computer-assisted personal interview. Sample size of 13,572 respondents with an 80% response rate (weighted). Analytic sample: n = 13,572. Accessible via Stats NZ procedures.	**Alcohol use**. Prevalence of lifetime abstainers, former drinkers, current drinkers, relative consumption of alcohol between Māori and non-Māori, by sex and age group.	Age, sex and ethnicity.

Data	Description	Measures	Disaggregation
Stats NZ Alcohol available for consumption: Year ended December 2018.	National statistics; year 2018. Stats NZ collects data from New Zealand Customs Service (excise duty taxes on alcohol produced for local consumption), which are integrated with Stats NZ data on imports. Publicly accessible online.	**Alcohol use**. Per capita consumption (litres of ethanol per person per year for population aged 15 years+).	Not available.
WHO Global Information System on Alcohol and Health.	Global alcohol indicator tool; year 2019. Aotearoa New Zealand-specific points derived or modelled from multiple data sources (including Aotearoa New Zealand data) using the GISAH methodology. Key data inputs include Stats NZ alcohol national statistics. Publicly accessible online.	**Alcohol use**. Aotearoa New Zealand-specific unrecorded alcohol use (as % of recorded); tourist alcohol use (as % of total [recorded + unrecorded] alcohol).	Not available.
Manatū Hauora, mortality web tool.	Administrative data; year 2018. Deaths registered in New Zealand. Publicly accessible online.	**Health loss**. Counts of deaths by International Statistical Classification of Diseases and Related Health Problems (ICD) code.	Condition, age, sex and ethnicity.
Manatū Hauora, publicly funded hospital discharges.	Administrative data capturing condition-specific counts of hospitalisations. Dates 1 July 2017 to 30 June 2018. Publicly accessible online.	**Health loss.** Counts of hospital discharges by ICD code of primary diagnosis and external cause (separate datasets).	Condition, age, sex and ethnicity.
Manatū Hauora, cancer registry.	Population-based registry of cancer incidence data. We accessed unit record level cancer registrations for 2018, using custom datasets provided by Manatū Hauora.	**Health loss.** Counts of cancer registrations by cancer site (ICD-10-AM).	Condition, age, sex, and ethnicity.
Accident Compensation Corporation injury claims.	Data captured from injury claims lodged to ACC for 2017/2018 financial year. The claim is a request for ACC to help cover the costs of medical bills, treatment, help at home and	**Health loss**. Counts of ACC claims by read code (ACC coding system); mapped to ICD codes by ACC and provided to authors (see	Condition, age, sex and ethnicity.

Data	Description	Measures	Disaggregation
	work, and help with income. It also does not reflect injuries for which an ACC claim is not filed (minor injuries).	supplementary methods (SM2) for mapping).	
Global Burden of Disease Study 2019 Results Tool.	Global health loss study; used estimates for 2018 from the 2019 study which covers years 1990-2019. Comprehensive international study on diseases and injuries. Aotearoa New Zealand-specific estimates derived or modelled from multiple data sources (including Aotearoa New Zealand data) using the GBD methodology. Publicly accessible online.	**Health loss.** Aotearoa New Zealand-specific years lived with disability (YLDs), years of life lost (YLLs) and DALYs for each alcohol-related condition.	Condition, sex, age. Data by ethnicity not available.
Stats NZ, 2018 estimated resident population, (age and sex by ethnic group).	Census dataset; year 2018. Consists of combined census forms and administrative data; methods involve a degree of imputation. Publicly accessible online.	**Population size.**	Age, sex and ethnicity.

Analysis

Using InterMAHP, a single AAF estimate for morbidity and mortality was calculated by ethnicity, sex, and age group for each condition associated with alcohol. InterMAHP includes the ability to choose from different relative risk libraries. We selected the GBD relative risks as this would match this study's later use of GBD DALY estimates. The alternative was to use the WHO/GSRAH relative risks. Estimates of condition-specific health loss were calculated by multiplying the Aotearoa New Zealand derived AAFs by age group, sex, and ethnicity-specific health loss counts (e.g. number of deaths). The analysis was conducted in R (version 4.3.1) and the corresponding code is available on request. Analysis for alcohol-attributable DALYs by ethnicity was not possible due to the GBD Results Tool not stratifying health loss by ethnicity. Age and sex standardised rates ('standardised rate' from here on) were calculated based on the 2018 Aotearoa New Zealand estimated resident population (using the estimated resident Māori population as the reference group) for consistency with the population of interest in this work.

Sensitivity analyses

Unless specified, the results presented throughout this report are the 'net' alcohol-attributable outcomes, that is, where the outcome encompasses both positive and negative effects of alcohol consumption. We use the term 'gross' to specify results where we have assumed there are no

potential protective effects of alcohol consumption. Specifically, gross outcomes are the result of removing identifiable potential protective effects from net outcomes.

The GBD relative risk relationships used in InterMAHP suggest a negative association between low levels of alcohol consumption and ischaemic heart disease, diabetes, hypertension, and ischaemic stroke.[79] Particularly for ischaemic heart disease, the negative association observed within the relative risk curve is contested with increasing evidence which shows that there is no benefit at low levels of alcohol consumption[34] or that any possible risk reduction is mitigated by binge drinking.[69] Further, previous AAF work in Aotearoa New Zealand has reported on gross alcohol-attributable outcomes rather than net alcohol-attributable outcomes (e.g. that assumes there are potential protective effects).

Therefore, we conducted a sensitivity analysis whereby any AAFs that suggested a potential protective effect (e.g. AAF < 0) were set to zero to facilitate comparability between studies using a gross estimate and to acknowledge the contested nature of these potential protective effects. However, in practice, the AAFs for each age-sex-ethnicity subgroup are effectively net values because they will include both outcomes 'prevented' and caused but it was not possible to differentiate between these within each subgroup. As a result, our gross value is an underestimate of the total number of alcohol-attributable outcomes. This issue is also discussed in the limitations section of this report.

Approvals and consultation with Māori

This project received the following approvals: ethics approval from the University of Otago Ethics Committee (HD20/089); Stats New Zealand approval for use of confidential unit record files (CURFs) health survey datasets with alcohol use data (CURF2020-20). As per University of Otago procedures for new research, our proposal was reviewed by the Ngāi Tahu Research Consultation Committee (NTRCC 5745-21733); the provided feedback was incorporated into the project design. Approval was also provided by Manatū Hauora to use unit record level extracts developed for the BODE3 programme for the AAF work.

Results

Unless specified, the results presented below are the net alcohol-attributable outcomes, which assume there are potential protective effects at lower levels of alcohol consumption for ischaemic heart disease, diabetes and ischaemic stroke. The final sub-section in the results titled "Gross health impacts: assuming no protective effects" is the only place in the results where the gross health impacts are presented – noting the caveat outlined in the section 'Sensitivity analyses'.

Alcohol-attributable fractions for Aotearoa New Zealand

The InterMAHP-generated AAFs' estimates with 95% uncertainty intervals (UI) are presented in the supplementary material user guide (SM1). Twenty-six conditions are covered in the AAFs (four injuries categories, eight cancer categories, six cardiovascular disease (CVD) types, two communicable diseases and six other conditions). Three conditions are considered wholly attributable to alcohol and have AAFs of '1.00' (alcohol use disorder, alcoholic cardiomyopathy, and alcoholic gastritis). For each condition, there are 28 age, sex, and ethnicity subcategories. An AAF of 0.153 (breast cancer, Māori, females, aged 55-64) is interpreted as 15.3% of breast cancer cases among Māori females aged 55-64 years are attributable to alcohol.

The vast majority (92.2%) of AAFs indicate that alcohol increases the risk of a condition (e.g. positive value AAFs). For three conditions (ischaemic heart disease, ischaemic stroke, diabetes), the AAFs for 57 (7.8%) specific age, sex, ethnicity subgroups are negative values, and therefore, are estimated to reduce the risk of the condition. Among the AAFs for alcohol-attributable morbidity and mortality, the magnitude, i.e. the estimated size of the causal contribution of alcohol, ranges substantially between conditions. The highest partially attributable AAFs are seen in the 'other' condition category (liver cirrhosis 0.817; pancreatitis: 0.550) and the cancer category (nasopharyngeal: 0.600, other pharyngeal: 0.600, lip and oral cavity cancer: 0.595). Within the injury category, the highest observed AAFs are for self-harm (0.279), transport (0.214) and interpersonal violence (0.209).

There are variations in AAFs according to sex, ethnicity, and age. For almost all conditions, males have higher AAFs, and thus a higher proportion of alcohol-attributable disease and injury. The exceptions are breast cancer and oesophageal cancer, where females have higher AAFs. Māori generally experience higher AAFs than non-Māori, except for Māori females aged 65+ who have lower AAFs than non-Māori females of the same age.

Mortality

Number of alcohol-attributable deaths

In total, 901 deaths in 2018 (95%UI 681 - 1104) were attributable to alcohol, or 2.7% of deaths from all causes (Table 5). Males were overrepresented with 753 deaths (95%UI 612 - 870), which represents 84% of all alcohol-attributable deaths. For those aged 15-34, alcohol-attributable deaths contributed 12.6% of all deaths in 2018 compared to 7.7% for people aged 35-64 and 1.4% for those aged over 64.

Cancers contributed the largest proportion of mortality with an estimated 376 deaths (95%UI 323 - 420) or 42% of all alcohol-attributable deaths. Alcohol-attributable cancer deaths were concentrated

in males (55%, n = 207, 95%UI 180 - 226) and people aged 65+ (66%, n = 251, 95%UI 213 - 283). Injuries contributed the second largest proportion of alcohol-attributable mortality with 296 deaths (95%UI 257 - 328) or 33% of all alcohol-attributable deaths. Deaths by injury were concentrated in males (76% of injury deaths, n = 227, 95%UI 198 - 248) and those aged 35-64 (42% of injury deaths, n = 125, 95%UI 109 - 136).

To account for differences in age and sex structure between Māori and non-Māori populations, we calculated standardised rates of alcohol-attributable health loss. Māori had a standardised rate of alcohol-attributable mortality that was twice that of non-Māori (0.309 compared to 0.153 deaths per 1,000 people) (see supplementary results, SM3). Conditions where Māori had a substantially higher standardised rate of alcohol-attributable mortality than non-Māori included: alcoholic cardiomyopathy (3.92 times higher); alcoholic gastritis (6.27 times higher); hypertension (2.88 times higher); interpersonal violence (4.67 times higher) and liver cancer (2.89 times higher). Māori had a lower standardised rate of alcohol-attributable mortality than non-Māori for colorectal cancer (0.21 times lower); liver cirrhosis (0.40 times lower) and pharyngeal cancer (3.68 times lower). For all remaining conditions, Māori had between one- and three-times higher standardised rates of alcohol-attributable mortality, including all injury conditions, which are large drivers of alcohol-attributable mortality.

Table 5. Total and alcohol-attributable deaths for each disease or injury condition by ethnicity, sex and age group

Condition group	Demographic group		Total* n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
All deaths	**All**	All	32,933	901 (681 – 1,104)	2.7 (2.1 – 3.4)
	Ethnicity	Māori	3,706	173 (147 – 195)	4.7 (4.0 – 5.3)
		Non-Māori	29,227	728 (535 – 908)	2.5 (1.8 – 3.1)
	Sex	Female	16,083	148 (69 – 234)	0.9 (0.4 – 1.5)
		Male	16,850	753 (612 – 870)	4.5 (3.6 – 5.2)
	Age group	15-34	784	99 (85 – 110)	12.6 (10.9 – 14.1)
		35-64	5,476	422 (365 – 467)	7.7 (6.7 – 8.5)
		65+	26,673	380 (231 – 526)	1.4 (0.9 – 2.0)
Injuries	**All**	All	2,147	296 (257 – 328)	13.8 (12.0 – 15.3)
	Ethnicity	Māori	381	62 (54 – 69)	16.3 (14.1 – 18.0)
		Non-Māori	1,766	234 (203 – 259)	13.3 (11.5 – 14.7)
	Sex	Female	808	70 (59 – 79)	8.6 (7.3 – 9.8)
		Male	1,339	227 (198 – 248)	16.9 (14.8 – 18.5)
	Age group	15-34	527	80 (68 – 90)	15.1 (12.8 – 17.0)
		35-64	686	125 (109 – 136)	18.2 (16.0 – 19.9)
		65+	934	92 (80 – 101)	9.8 (8.5 – 10.8)
Cardiovascular conditions	**All**	All	10,312	21 (-65 – 114)	0.2 (-0.6 – 1.1)
	Ethnicity	Māori	1,116	55 (46 – 63)	4.9 (4.1 – 5.6)
		Non-Māori	9,196	-33 (-112 – 51)	-0.4 (-1.2 – 0.6)
	Sex	Female	5,030	-106 (-131 – -71)	-2.1 (-2.6 – -1.4)
		Male	5,282	128 (66 – 185)	2.4 (1.2 – 3.5)
	Age group	15-34	53	10 (10 – 10)	18.9 (18.5 – 19.4)

Condition group	Demographic group		Total* n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
		35-64	1,257	73 (57 – 86)	5.8 (4.6 – 6.8)
		65+	9,002	-61 (-133 – 18)	-0.7 (-1.5 – 0.2)
Diabetes	**All**	All	901	-52 (-59 – -44)	-5.8 (-6.6 – -4.9)
	Ethnicity	Māori	221	-10 (-12 – -9)	-4.6 (-5.4 – -3.8)
		Non-Māori	680	-42 (-47 – -36)	-6.2 (-6.9 – -5.3)
	Sex	Female	395	-58 (-58 – -55)	-14.6 (-14.8 – -14.0)
		Male	506	6 (-1 – 11)	1.1 (-0.1 – 2.2)
	Age group	15-34	8	0 (0 – 0)	-3.3 (-4.3 – -2.3)
		35-64	193	-8 (-10 – -5)	-4.0 (-5.3 – -2.8)
		65+	700	-44 (-48 – -39)	-6.3 (-6.9 – -5.5)
Cancers	**All**	All	9,798	376 (323 – 420)	3.8 (3.3 – 4.3)
	Ethnicity	Māori	1,126	36 (32 – 40)	3.2 (2.8 – 3.6)
		Non-Māori	8,672	340 (291 – 380)	3.9 (3.4 – 4.4)
	Sex	Female	4,623	170 (142 – 194)	3.7 (3.1 – 4.2)
		Male	5,175	207 (180 – 226)	4.0 (3.5 – 4.4)
	Age group	15-34	84	2 (2 – 3)	2.8 (2.4 – 3.3)
		35-64	2,286	123 (108 – 134)	5.4 (4.7 – 5.9)
		65+	7,428	251 (213 – 283)	3.4 (2.9 – 3.8)
Communicable diseases	**All**	All	1,040	39 (27 – 50)	3.7 (2.6 – 4.9)
	Ethnicity	Māori	85	5 (4 – 6)	5.8 (4.6 – 6.9)
		Non-Māori	955	34 (23 – 45)	3.5 (2.4 – 4.7)
	Sex	Female	591	13 (8 – 18)	2.1 (1.4 – 3.0)
		Male	449	26 (19 – 33)	5.8 (4.1 – 7.3)
	Age group	15-34	9	0 (0 – 0)	3.2 (2.2 – 4.1)
		35-64	119	5 (4 – 6)	4.2 (3.2 – 5.1)
		65+	912	33 (23 – 44)	3.7 (2.5 – 4.8)
Other	**All**	All	8,735	220 (199 – 236)	2.5 (2.3 – 2.7)
	Ethnicity	Māori	777	25 (23 – 27)	3.2 (3.0 – 3.4)
		Non-Māori	7,958	195 (176 – 210)	2.5 (2.2 – 2.6)
	Sex	Female	4,636	60 (49 – 70)	1.3 (1.1 – 1.5)
		Male	4,099	160 (150 – 167)	3.9 (3.7 – 4.1)
	Age group	15-34	103	7 (6 – 7)	6.5 (5.8 – 7.0)
		35-64	935	105 (97 – 110)	11.2 (10.3 – 11.8)
		65+	7,697	109 (96 – 119)	1.4 (1.3 – 1.5)

*Total refers to the total of all deaths for that disease category, e.g. not only the alcohol-attributable disease and injury conditions. For example, for cancer, 3.8% reflects the proportion of all cancer deaths, not just those associated with alcohol consumption.

Distribution of alcohol-attributable deaths by sex and age category

Figure 1 provides an overview of alcohol-attributable deaths for each sex, age and ethnicity subgroup by condition type. Our analysis shows that a large amount of the alcohol-attributable mortality for Māori is due to injuries and cardiovascular disease, compared to cancers for non-Māori, across both sexes. For men, there is minimal reduced risk from low-level alcohol consumption, represented by bars below zero on the y axis. In contrast, for women, particularly non-Māori women, there are some possible protective effects for cardiovascular disease and diabetes in the oldest age group (75-99),

which should be interpreted with caution as outlined in more detail in the discussion. Across all sex and ethnic groups, injuries typically contribute the greatest proportion of alcohol-related deaths for those younger than age 45.

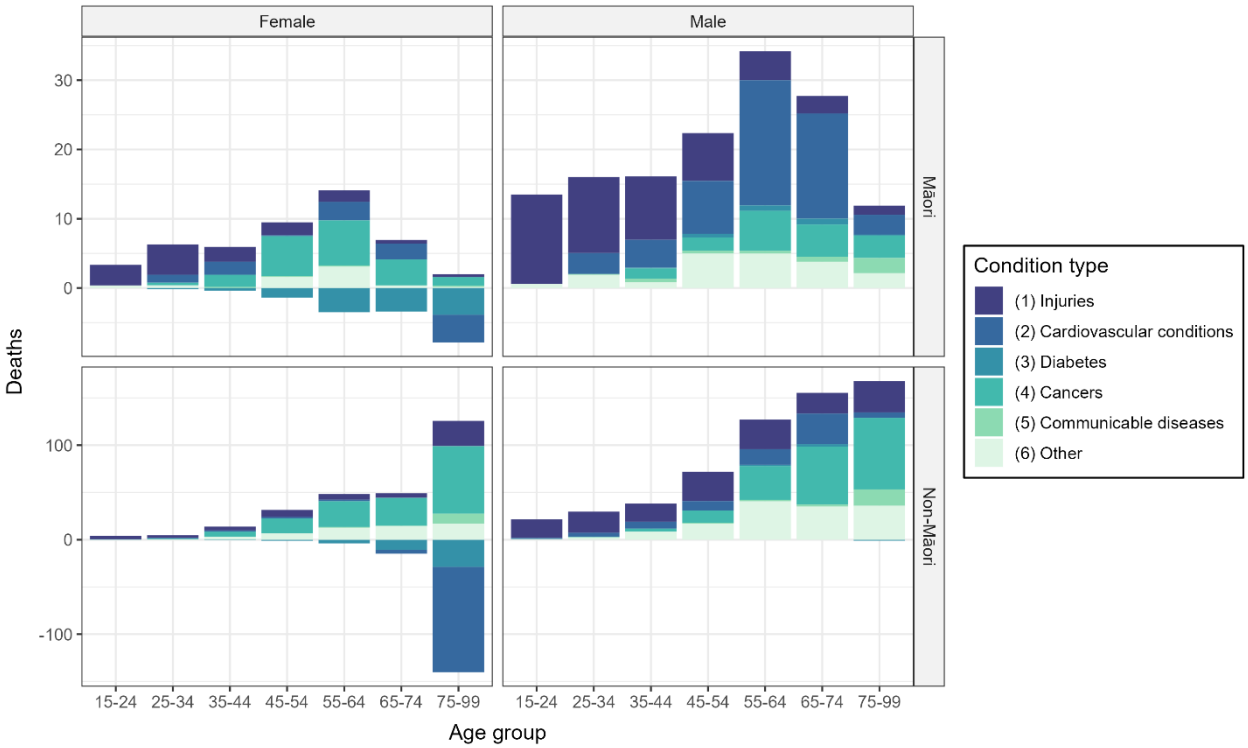

Figure 1. Alcohol-attributable deaths by condition type, sex, age and ethnicity

Proportion of deaths attributable to alcohol for each condition

Figure 2 shows the number of total (dark blue) and alcohol-attributable (light blue) deaths by disease and injury conditions. Alcoholic cardiomyopathy causes more deaths than any other single alcohol-attributable condition. While alcohol use disorders and alcoholic gastritis are wholly attributable to alcohol, the total number of deaths from these conditions (n = 61) is lower than partially attributable but more prevalent and/or severe conditions, such as colorectal cancer (e.g. 11.9% of cancer deaths with a total of 149). This shows that while an AAF can be relatively low for a disease, its public health burden can be high if the condition has a high prevalence or severity.

The number and percentage of alcohol-attributable mortality for each disease and injury condition is available in the supplementary results (SM3). The three wholly attributable alcohol conditions (alcohol use disorders, alcoholic cardiomyopathy and alcoholic gastritis) collectively account for over a third of all alcohol-attributable deaths (n = 330 deaths). A significant proportion of cancer mortality was attributable to alcohol use including breast (12.3% of all breast cancers, n = 84); colorectal (11.9%, n = 149); laryngeal (27.4%, n = 8);lip and oral cavity (43%, n = 44); liver (11.4%, n = 32); nasopharyngeal (45.3%, n = 5); oesophageal (12.2%, n = 31); pharyngeal (51.6%, n = 22).

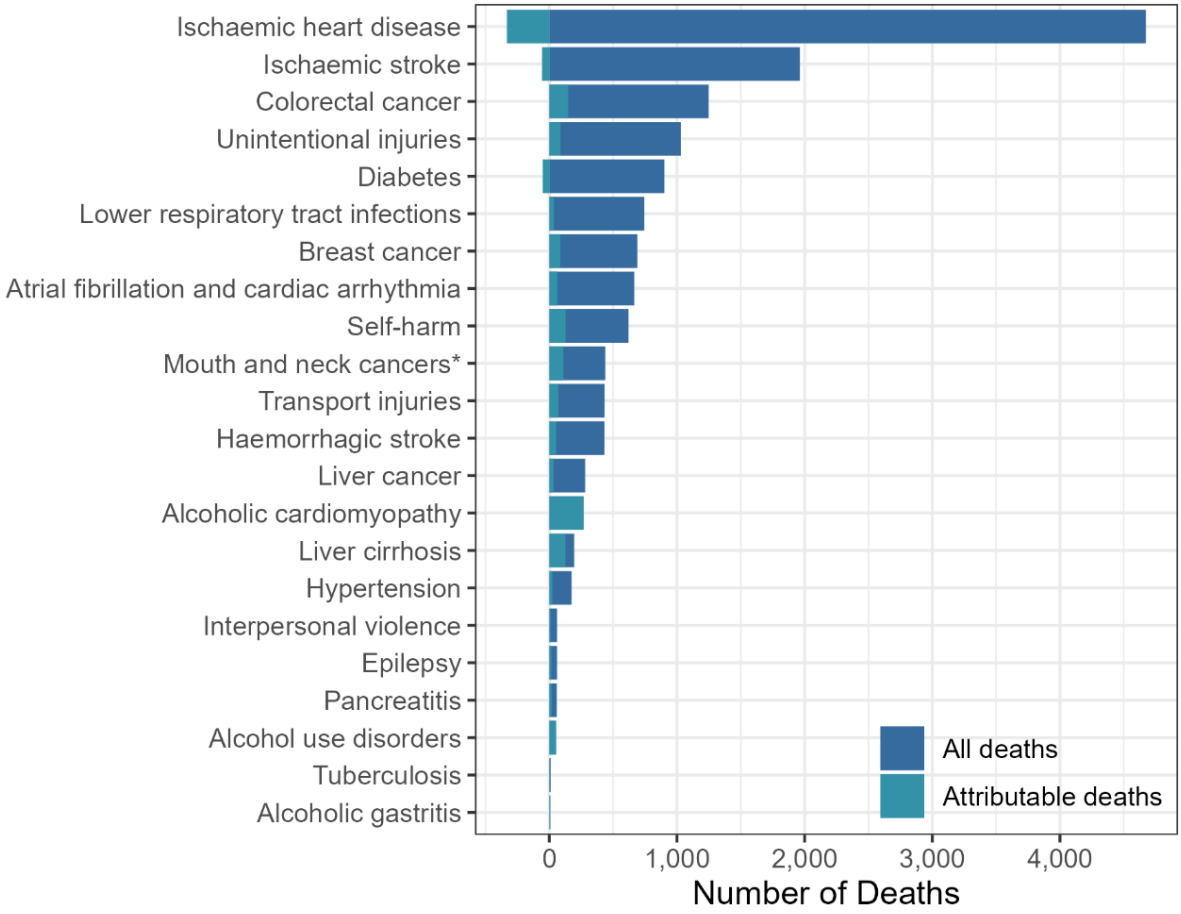

Figure 2. Total and alcohol-attributable deaths by disease and injury condition

Cancer registrations

Number of alcohol-attributable cancer registrations

In total, 1,250 cancer registrations in 2018 (95%UI 1,084 – 1,383) were attributable to alcohol, or 4.8% of all cancer registrations (Table 6). Females were slightly overrepresented with 660 cancer registrations (95%UI 563 - 744), which represents 53% of all alcohol-attributable cancer registrations. For those aged 34-64, alcohol-attributable cancer registrations contributed 6.4% of all cancer registrations in 2018 compared to 2.7% for people aged 15-34 and 3.8% for those aged over 64. Māori had a standardised rate of alcohol-attributable cancer that was 21% higher than non-Māori (0.263 compared to 0.217 cancers per 1,000 people) (see supplementary results, SM3). Cancers where Māori had substantially higher standardised rates of alcohol-attributable cancer registrations than non-Māori included: liver (305% higher), breast (38% higher); nasopharyngeal (51% higher); and pharyngeal (17% higher) cancers. Māori had a lower standardised rate of alcohol-attributable cancer registration than non-Māori for colorectal cancer (18% lower) and about the same rates for oesophageal cancer (4% higher).

Table 6. Total and alcohol-attributable cancer registrations by ethnicity, sex and age group

Demographic group		Total n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
All	All	26,155	1,250 (1,084 – 1,383)	4.8 (4.1 – 5.3)
Ethnicity	Māori	2,850	147 (130 – 161)	5.2 (4.6 – 5.7)
	Non-Māori	23,305	1,102 (955 – 1,221)	4.7 (4.1 – 5.2)
Sex	Female	12,199	660 (563 – 744)	5.4 (4.6 – 6.1)
	Male	13,956	589 (521 – 638)	4.2 (3.7 – 4.6)
Age group	15-34	655	17 (15 – 20)	2.7 (2.3 – 3.0)
	35-64	10,009	642 (566 – 700)	6.4 (5.7 – 7.0)
	65+	15,491	590 (503 – 663)	3.8 (3.2 – 4.3)

Distribution of alcohol-attributable cancer registrations by sex and age category

Figure 3 provides an overview of alcohol-attributable cancer registrations for each sex, age and ethnicity subgroup by cancer type. Our analysis shows that the majority of the cancer burden for females is due to breast cancer, while the colorectal and liver cancers contribute the greatest number of cancer registrations for men. The burden of alcohol-attributable cancers is observed much earlier for women (from age 35 onwards) compared to men (from age 45 onwards). The sex-specific distribution of cancer registrations by age likely means women experience a greater health burden from alcohol-attributable cancers as a result of additional years of life lost and/or years lived in disability. For women, the higher risk of developing breast cancer than men results in a greater overall proportion of alcohol-attributable cancers despite lower overall alcohol consumption. For non-Māori women, there is a substantial number of alcohol-attributable colorectal cancer registrations compared to Māori women.

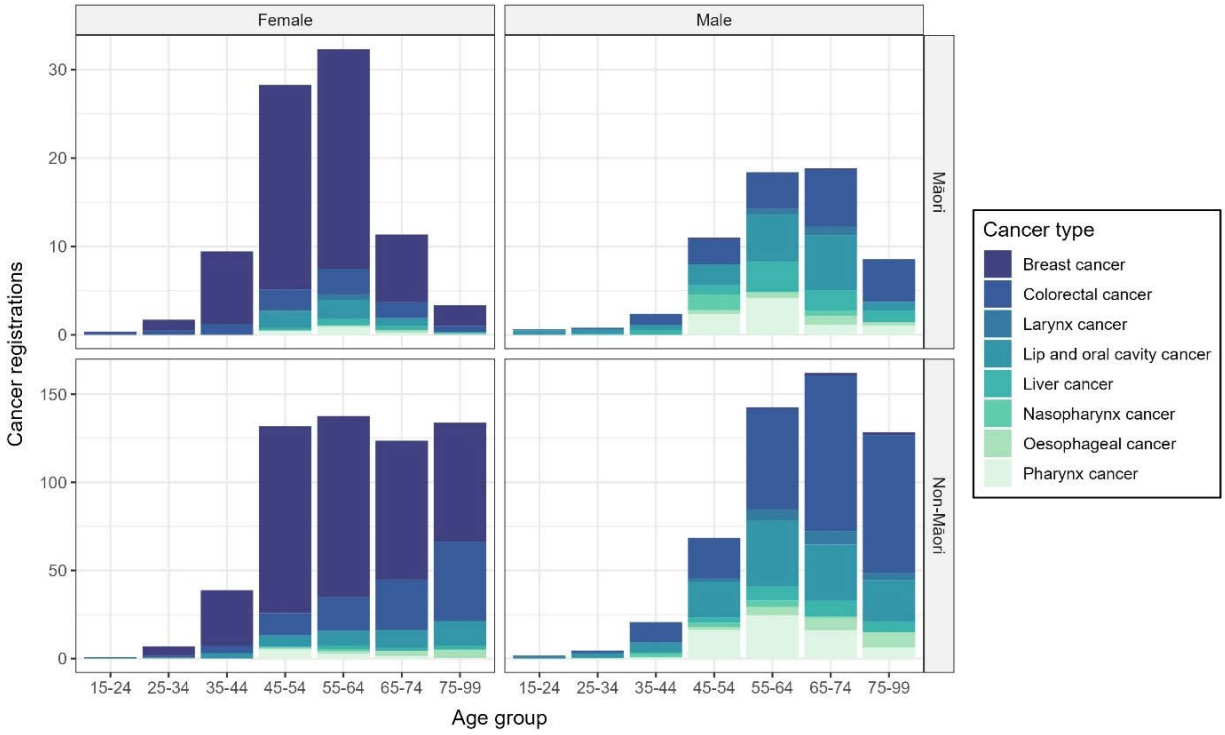

Figure 3. Alcohol-attributable cancer registrations by condition type, sex, age and ethnicity

Proportion of cancer registrations attributable to alcohol for each cancer type

Figure 4 shows the number of total (dark blue) and alcohol-attributable (light blue) cancer registrations by cancer type. Collectively, breast cancer and colorectal cancer made up 69% of all alcohol-attributable cancers in 2018 (see supplementary results SM3). An estimated 13.0% (n = 464) of breast cancer registrations and 12.6% (n = 401) of colorectal cancer registrations were attributable to alcohol in 2018. The proportion of cancers attributable to alcohol were substantially higher for nasopharyngeal (53.6% of all nasopharyngeal cancers), pharyngeal (54.7%), lip and oral cavity (46.8%), laryngeal (29.8%) cancers compared to breast and colorectal cancers. However, the incidence of breast and colorectal cancers are substantially higher in Aotearoa New Zealand than other cancers with higher alcohol-attributable fractions which demonstrates the public health burden associated with more common conditions despite lower alcohol-attributable fractions.

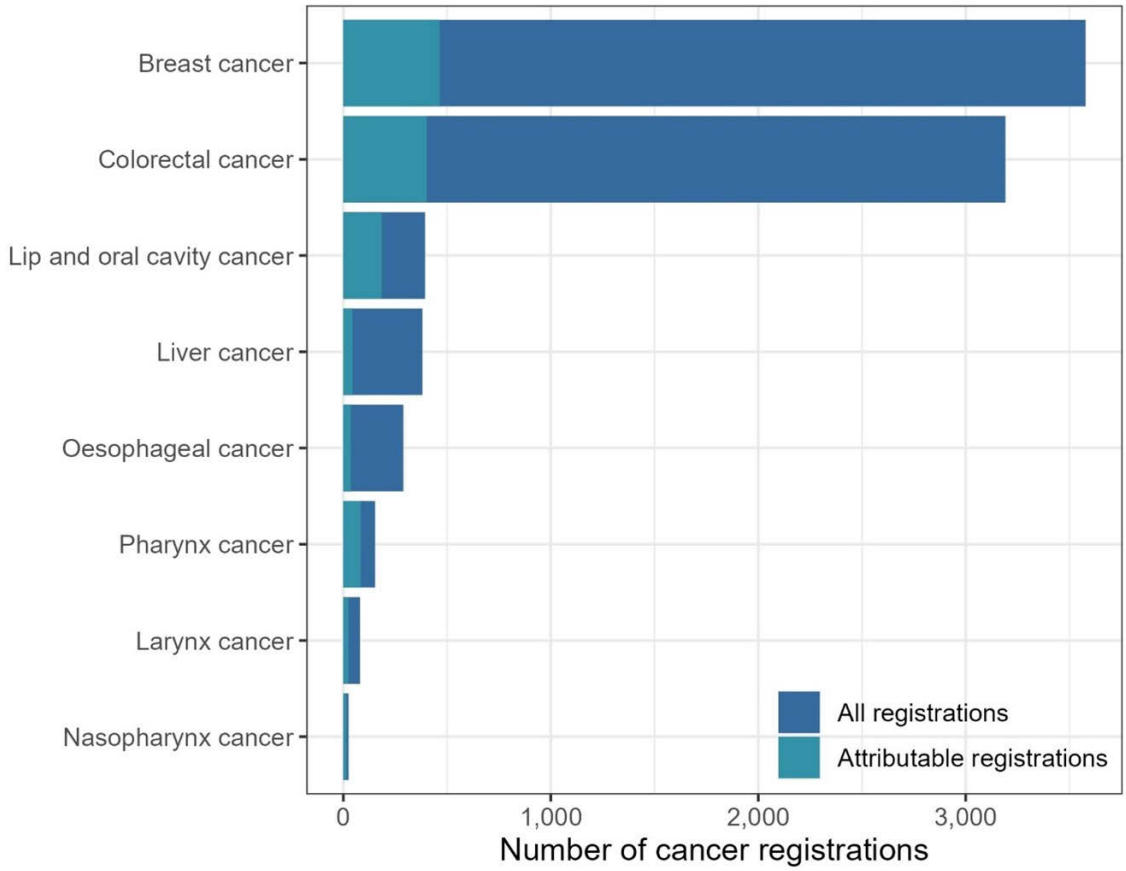

Figure 4. Number of total and alcohol-attributable cancer registrations by cancer type

Publicly funded hospitalisations

Number of alcohol-attributable hospitalisations

In total, 29,282 hospitalisations (95%UI 25,713 − 32,318) were attributable to alcohol in 2018 or 2.8% of all hospitalisations (Table 7). Males were overrepresented in alcohol-attributable hospitalisations with 18,779 (95%UI 16,564 − 20,501) or 64% of all alcohol-attributable hospitalisations. Alcohol-attributable hospitalisations made up 4.1% of all hospitalisations for males compared to 1.8% for women. Those aged 35-64 had the highest burden of alcohol-attributable hospitalisations with 3.6% of all hospitalisations compared to 2.9% for those aged 15-34 and 2.0% for those aged 65 and over.

Injuries contributed the highest number of alcohol-attributable hospitalisations with an estimated 12,766 (95%UI 11,190 − 14,055) or 44% of all alcohol-attributable hospitalisations and 10.3% of all hospitalisations due to injuries. Males were also more likely to be hospitalised for an alcohol-attributable injury with 12.9% of all injuries being alcohol-attributable for men, compared to 7.6% for women. Conditions in the 'other' category contributed the second highest burden of alcohol-attributable hospitalisations with 11,764 (95%UI 11,287 − 12,135) or 40.2% of all alcohol-attributable hospitalisations.

The standardised rate of alcohol-attributable hospitalisation for Māori is 1.5 times higher than for non-Māori (9.3 compared to 6.2 hospitalisations per 1,000 people) (supplementary results, SM3). The

standardised relative rate of hospitalisation in Māori compared to non-Māori was 2.50 times higher for cardiomyopathy, 4.98 times higher for hypertension, 3.84 times higher for interpersonal violence and 2.46 times for liver cancer. Conditions that are driving inequities in alcohol-attributable hospitalisations between Māori and non-Māori based on both their prevalence and higher burden include: unintentional injuries (1.9 hospitalisations for Māori per 1000 population, 1.3 times higher than non-Māori); alcoholic gastritis (1.3 hospitalisations for Māori per 1000 population, 1.4 times higher than non-Māori) and alcohol use disorders (1.4 hospitalisations for Māori per 1000 population, 1.2 times higher than non-Māori).

Table 7. Total and alcohol-attributable hospitalisations for each disease or injury condition by ethnicity, sex and age group

Condition group	Demographic group		Total* n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
All hospitalisations	**All**	All	1,054,514	29,282 (25,713 – 32,318)	2.8 (2.4 – 3.1)
	Ethnicity	Māori	152,637	5,210 (4,630 – 5,685)	3.4 (3.0 – 3.7)
		Non-Māori	901,877	24,072 (21,084 – 26,634)	2.7 (2.3 – 3.0)
	Sex	Female	598,683	10,502 (9,150 – 11,818)	1.8 (1.5 – 2.0)
		Male	455,831	18,779 (16,564 – 20,501)	4.1 (3.6 – 4.5)
	Age group	15-34	258,761	7,537 (6,854 – 8,123)	2.9 (2.6 – 3.1)
		35-64	374,286	13,334 (11,946 – 14,432)	3.6 (3.2 – 3.9)
		65+	421,467	8,411 (6,913 – 9,763)	2.0 (1.6 – 2.3)
Injuries	**All**	All	123,719	12,766 (11,190 – 14,055)	10.3 (9.0 – 11.4)
	Ethnicity	Māori	18,761	2,322 (2,034 – 2,552)	12.4 (10.8 – 13.6)
		Non-Māori	104,958	10,445 (9,156 – 11,503)	10.0 (8.7 – 11.0)
	Sex	Female	60,394	4,602 (3,925 – 5,209)	7.6 (6.5 – 8.6)
		Male	63,325	8,165 (7,264 – 8,845)	12.9 (11.5 – 14.0)
	Age group	15-34	36,897	3,937 (3,395 – 4,395)	10.7 (9.2 – 11.9)
		35-64	38,904	4,850 (4,305 – 5,268)	12.5 (11.1 – 13.5)
		65+	47,918	3,979 (3,489 – 4,391)	8.3 (7.3 – 9.2)
Cardiovascular conditions	**All**	All	90,335	1,707 (931 – 2,421)	1.9 (1.0 – 2.7)
	Ethnicity	Māori	11,262	384 (294 – 462)	3.4 (2.6 – 4.1)
		Non-Māori	79,073	1,323 (637 – 1,958)	1.7 (0.8 – 2.5)
	Sex	Female	38,525	-14 (-217 – 229)	0.0 (-0.6 – 0.6)
		Male	51,810	1,720 (1,148 – 2,192)	3.3 (2.2 – 4.2)
	Age group	15-34	2,798	82 (72 – 90)	2.9 (2.6 – 3.2)
		35-64	28,328	1,160 (848 – 1,421)	4.1 (3.0 – 5.0)
		65+	59,209	465 (10 – 909)	0.8 (0.0 – 1.5)
Diabetes	**All**	All	5,714	-309 (-357 – -257)	-5.4 (-6.3 – -4.5)
	Ethnicity	Māori	1,262	-74 (-86 – -61)	-5.8 (-6.8 – -4.8)
		Non-Māori	4,452	-235 (-271 – -196)	-5.3 (-6.1 – -4.4)
	Sex	Female	2,441	-356 (-363 – -338)	-14.6 (-14.9 – -13.8)
		Male	3,273	47 (5 – 81)	1.4 (0.2 – 2.5)
	Age group	15-34	1,310	-93 (-99 – -85)	-7.1 (-7.6 – -6.5)
		35-64	2,077	-89 (-115 – -64)	-4.3 (-5.5 – -3.1)
		65+	2,327	-126 (-143 – -108)	-5.4 (-6.1 – -4.6)
Cancers	**All**	All	57,919	1,580 (1,373 – 1,744)	2.7 (2.4 – 3.0)

Condition group	Demographic group		Total* n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
	Ethnicity	Māori	4,969	196 (172 – 213)	3.9 (3.5 – 4.3)
		Non-Māori	52,950	1,385 (1,201 – 1,531)	2.6 (2.3 – 2.9)
	Sex	Female	25,779	707 (599 – 800)	2.7 (2.3 – 3.1)
		Male	32,140	874 (774 – 944)	2.7 (2.4 – 2.9)
	Age group	15-34	1,549	20 (17 – 22)	1.3 (1.1 – 1.4)
		35-64	18,482	763 (674 – 829)	4.1 (3.6 – 4.5)
		65+	37,888	798 (682 – 893)	2.1 (1.8 – 2.4)
Communicable diseases	**All**	All	54,449	1,773 (1,290 – 2,221)	3.3 (2.4 – 4.1)
	Ethnicity	Māori	8,434	314 (232 – 385)	3.7 (2.8 – 4.6)
		Non-Māori	46,015	1,459 (1,058 – 1,836)	3.2 (2.3 – 4.0)
	Sex	Female	28,974	429 (285 – 591)	1.5 (1.0 – 2.0)
		Male	25,475	1,344 (1,005 – 1,630)	5.3 (3.9 – 6.4)
	Age group	15-34	11,364	140 (101 – 179)	1.2 (0.9 – 1.6)
		35-64	17,305	691 (521 – 838)	4.0 (3.0 – 4.8)
		65+	25,780	941 (669 – 1,204)	3.7 (2.6 – 4.7)
Other	**All**	All	722,378	11,764 (11,287 – 12,135)	1.6 (1.6 – 1.7)
	Ethnicity	Māori	107,949	2,069 (1,984 – 2,133)	1.9 (1.8 – 2.0)
		Non-Māori	614,429	9,695 (9,303 – 10,002)	1.6 (1.5 – 1.6)
	Sex	Female	442,570	5,134 (4,920 – 5,327)	1.2 (1.1 – 1.2)
		Male	279,808	6,630 (6,367 – 6,808)	2.4 (2.3 – 2.4)
	Age group	15-34	204,843	3,451 (3,369 – 3,521)	1.7 (1.6 – 1.7)
		35-64	269,190	5,959 (5,712 – 6,140)	2.2 (2.1 – 2.3)
		65+	248,345	2,353 (2,205 – 2,474)	0.9 (0.9 – 1.0)

*Total refers to the total of all hospitalisations within that disease category that could be attributable to alcohol (rather than all hospitalisations – e.g. total in cancers is the total of hospitalisations for the eight alcohol-attributable cancers not all cancers).

Distribution of alcohol-attributable hospitalisations by sex and age category

Figure 5 provides an overview of alcohol-attributable hospitalisations for each sex, age and ethnicity subgroup by condition type. As seen in Table 7, Figure 5 provides a visual representation of the extent to which alcohol-attributable hospitalisations are due to injuries and 'other' conditions across all sex, age and ethnicity groups. For Māori, hospitalisations for all conditions peak at earlier ages (younger than age 45) then gradually decrease over time, while hospitalisations for non-Māori are higher in older age groups. For non-Māori, injuries appear to peak in the older age groups starting around age 55-64, while Māori injury hospitalisations appear to be concentrated in the younger age groups (e.g. younger than 45). Any potential reduced risk of hospitalisation from low-level alcohol consumption is concentrated in females above age 75 for cardiovascular disease and diabetes (any bar below 0 in Figure 5).

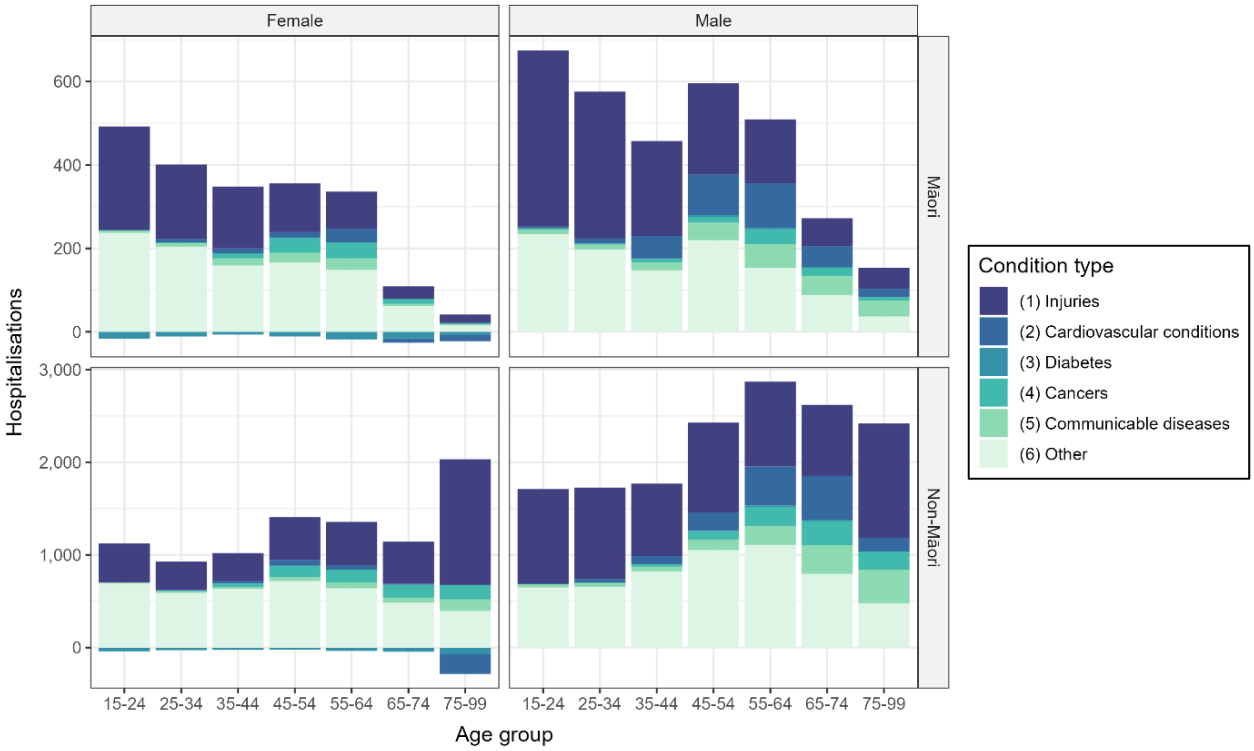

Figure 5. Alcohol-attributable hospitalisations by sex, age and ethnicity

Proportion of hospitalisations attributable to alcohol for each disease and injury condition

Figure 6 shows the total (dark blue) and alcohol-attributable (light blue) hospitalisations by condition on the top panel and a magnified version of the same figure on the bottom panel. The magnified version of the figure is required due to the large number of hospitalisations due to injuries compared to all other conditions. For hospitalisations, those wholly alcohol-attributable conditions (alcohol use disorder, alcoholic gastritis and alcoholic cardiomyopathy) contributed over a third of all alcohol-attributable hospitalisations (n = 9,993 or 34.1%). The full results for all total and alcohol-attributable hospitalisations for each condition are provided in supplementary results (SM3).

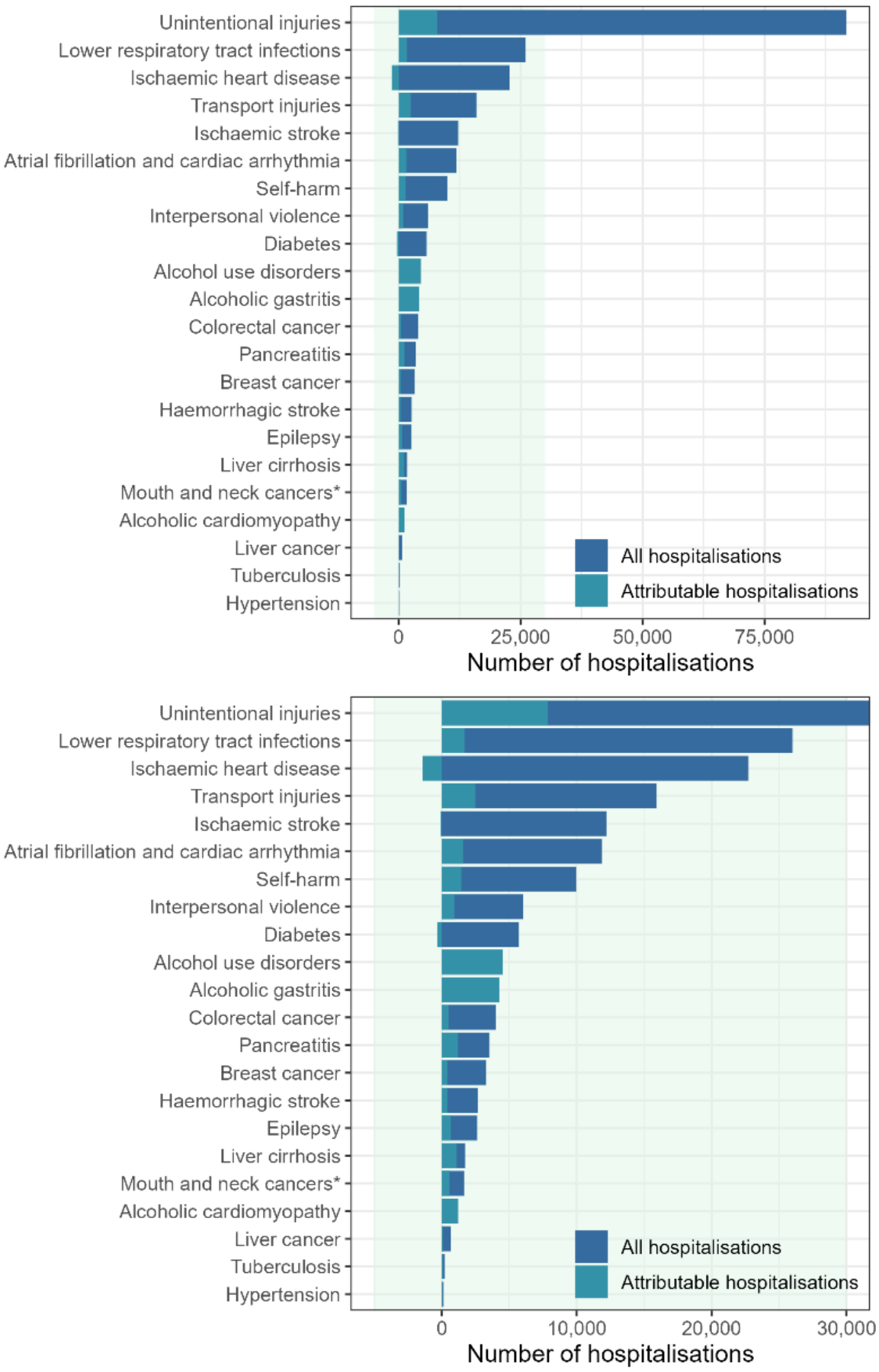

Figure 6. Total and alcohol-attributable hospitalisations (top) and magnified version of the same figure (bottom)

Accident Compensation Corporation injury claims

Number of alcohol-attributable injury claims

In total, there were an estimated 128,963 alcohol-attributable ACC injury claims (95%UI 114,324 – 140,681) contributing 8.9% of all ACC claims in 2018 (Table 8). Alcohol-attributable claims comprised a greater proportion of all claims for: Māori (9.9%) compared to non-Māori (8.7%); for males (10.8%) compared to females (6.8%); and for those aged 35-64 (9.7%) compared to those aged 15-34 (8.0%) and 65+ (8.4%), reflecting higher injury-related AAFs in these groups.

Unintentional injuries comprised the large majority of all alcohol-attributable ACC claims (n = 123,907 or 96.1%), with alcohol-attributable claims following the same distribution across ethnicity, sex and age as overall claims. Alcohol-attributable transport injuries comprised a greater proportion of all injuries (14.5%) compared to the overall contribution of alcohol to all ACC claims (8.9%). Alcohol-attributable transport injuries as a proportion of all transport injuries were highest for Māori (16.4% compared to 14.2% for non-Māori), males (18.4% compared to 11.0% for females) and those aged 35-64 (16.3% compared to 12.8% for those aged 15-34), which was mirrored for interpersonal violence (Māori = 15.0%; males = 18.4%; aged 35-64 = 14.9%) and self-harm (Māori 15.9%; males 21.3%; aged 35-64 18.1%) claims.

Table 8. Total and alcohol-attributable Accident Compensation Corporation (ACC) claims

Condition group	Demographic group		Total n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
All claims	**All**	All	1,453,730	128,963 (114,324 – 140,681)	8.9 (7.9 – 9.7)
	Ethnicity	Māori	162,056	16,078 (14,305 – 17,467)	9.9 (8.8 – 10.8)
		Non-Māori	1,291,674	112,885 (100,019 – 123,214)	8.7 (7.7 – 9.5)
	Sex	Female	706,116	47,861 (41,441 – 53,480)	6.8 (5.9 – 7.6)
		Male	747,614	81,102 (72,883 – 87,201)	10.8 (9.7 – 11.7)
	Age group	15-34	513,459	41,198 (36,163 – 45,349)	8.0 (7.0 – 8.8)
		35-64	660,773	64,260 (57,387 – 69,593)	9.7 (8.7 – 10.5)
		65+	279,498	23,505 (20,774 – 25,738)	8.4 (7.4 – 9.2)
Interpersonal violence	**All**	All	6,461	792 (683 – 884)	12.3 (10.6 – 13.7)
	Ethnicity	Māori	1,933	290 (253 – 320)	15.0 (13.1 – 16.5)
		Non-Māori	4,528	503 (430 – 565)	11.1 (9.5 – 12.5)
	Sex	Female	5,053	534 (452 – 605)	10.6 (9.0 – 12.0)
		Male	1,408	259 (231 – 279)	18.4 (16.4 – 19.8)
	Age group	15-34	3,746	390 (331 – 441)	10.4 (8.8 – 11.8)
		35-64	2,568	383 (335 – 422)	14.9 (13.0 – 16.4)
		65+	147	19 (17 – 21)	13.2 (11.5 – 14.6)
Self-harm	**All**	All	148	19 (15 – 22)	12.8 (10.4 – 14.9)
	Ethnicity	Māori	20	3 (3 – 4)	15.9 (12.9 – 18.4)
		Non-Māori	128	16 (13 – 18)	12.3 (10.0 – 14.3)
	Sex	Female	105	10 (8 – 12)	9.2 (7.3 – 11.2)
		Male	43	9 (8 – 10)	21.3 (17.9 – 24.0)

Condition group	Demographic group		Total n	Alcohol-attributable n (95%UI)	Alcohol-attributable % (95%UI)
	Age group	15-34	119	14 (11 – 16)	11.4 (9.2 – 13.5)
		35-64	29	5 (4 – 6)	18.1 (15.1 – 20.7)
		65+	0	0 (0 – 0)	0 (0.0 – 0.0)
Transport injuries	**All**	All	29,205	4,245 (3,730 – 4,670)	14.5 (12.8 – 16.0)
	Ethnicity	Māori	3,932	645 (568 – 706)	16.4 (14.5 – 18.0)
		Non-Māori	25,273	3,600 (3,162 – 3,963)	14.2 (12.5 – 15.7)
	Sex	Female	15,270	1,684 (1,454 – 1,892)	11.0 (9.5 – 12.4)
		Male	13,935	2,561 (2,276 – 2,777)	18.4 (16.3 – 19.9)
	Age group	15-34	12,778	1,641 (1,429 – 1,822)	12.8 (11.2 – 14.3)
		35-64	12,908	2,098 (1,856 – 2,291)	16.3 (14.4 – 17.7)
		65+	3,519	506 (445 – 557)	14.4 (12.7 – 15.8)
Unintentional injuries	**All**	All	1,417,916	123,907 (109,896 – 135,104)	8.7 (7.8 – 9.5)
	Ethnicity	Māori	156,171	15,140 (13,482 – 16,437)	9.7 (8.6 – 10.5)
		Non-Māori	1,261,745	108,767 (96,414 – 118,667)	8.6 (7.6 – 9.4)
	Sex	Female	685,688	45,634 (39,527 – 50,971)	6.7 (5.8 – 7.4)
		Male	732,228	78,272 (70,369 – 84,133)	10.7 (9.6 – 11.5)
	Age group	15-34	496,816	39,154 (34,392 – 43,070)	7.9 (6.9 – 8.7)
		35-64	645,268	61,774 (55,192 – 66,874)	9.6 (8.6 – 10.4)
		65+	275,832	22,980 (20,312 – 25,160)	8.3 (7.4 – 9.1)

Distribution of alcohol-attributable injury claims by ethnicity, sex and age

Figure 7 provides an overview of alcohol-attributable ACC claims across ethnicity, sex and age groups. As represented in Table 8, unintentional injuries comprised the majority of all claims across each group. For Māori males, there is a substantially higher number of claims in the earlier age groups (age 15-34) compared to older age groups, while for Māori females, there are relatively consistent numbers of claims from age 15 to 64, with a drop-off at age 65. The pattern by age observed for Māori females is also evident for non-Māori males but with substantially higher numbers of claims across the board. For non-Māori females, those aged 45-64 experienced the most alcohol-attributable claims of any age group.

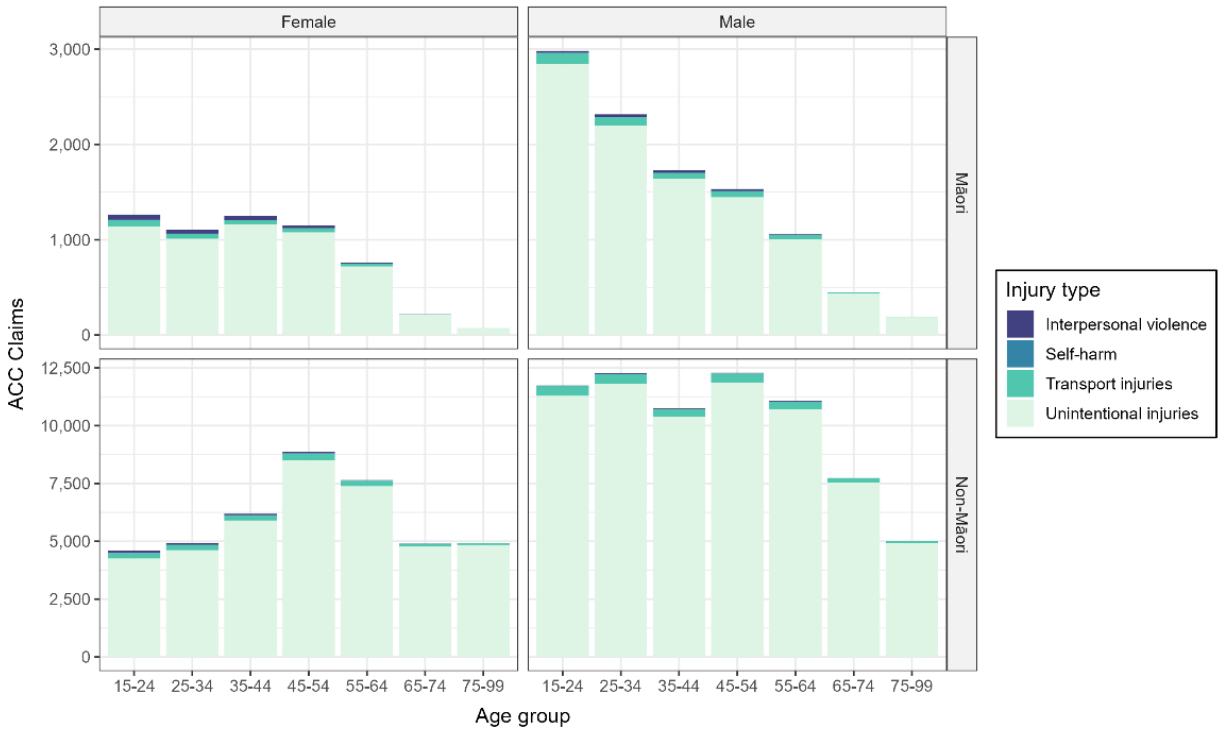

Figure 7. Distribution of Accident Compensation Corporation (ACC) claims across ethnicity, sex and age

Proportion of ACC claims attributable to alcohol for each condition

Figure 8 shows the number of total (dark blue) and alcohol-attributable (light blue) ACC claims across the four injury categories. The left panel demonstrates the overall contribution of unintentional injuries to both total and alcohol-attributable ACC claims. The right panel is a magnified version of the same figure to highlight the different proportion of those remaining injury conditions that are attributable to alcohol.

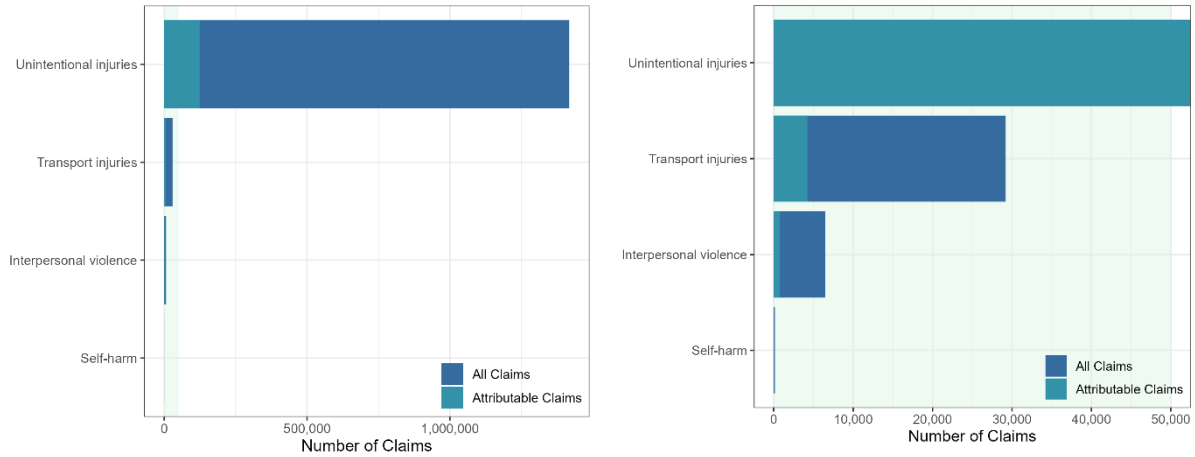

Figure 8. Total and alcohol-attributable Accident Compensation Corporation (ACC) claims (left) and magnified (right)

Disability adjusted life years (DALYs)

Number of alcohol-attributable DALYs

Table 9 shows the total number of alcohol-attributable DALYs by sex and age. Note, ethnicity-specific estimates for DALYs were not available from GBD, so we were unable to produce DALYs by ethnicity. In total, 49,742 DALYs (95%UI 42,988 - 55,518) across all disease and injury conditions were attributable to alcohol in 2018. The majority (76%) of these DALYs were experienced by males (n = 37,738, 95%UI 33,335 - 41,165). Those aged 35-64 experienced 55% of all DALYs (n = 27,433, 95%UI 24,598 - 29,646).

'Other' conditions contributed the most DALYs of any conditions with an estimated 22,150 (95%UI 21,424 - 22,676) or 45% of all alcohol-attributable DALYs. 'Other' conditions were followed by injuries (n = 17,962 (36.1%), 95%UI 15,720 - 19,736) and cancers (n = 10,227 (20.6%), 95%UI 8,867 - 11,307). For cardiovascular conditions, any potential reduced risk for low consumption is masked by the increased risk from moderate to high consumption at a population level. This masking also occurs at earlier ages whereby those aged 35-64 have already incurred a greater number of DALYs (1,994, 95%UI 1,304 - 2,580) than could be potentially prevented at ages 65+ (-1,563, 95%UI -2,849 - -218).

Table 9. Alcohol-attributable DALYs by condition category and demographic group

Demographic group		Injuries n (95%UI)	Cardiovascular conditions n (95%UI)	Diabetes n (95%UI)	Cancers n (95%UI)	Communicable diseases n (95%UI)	Other n (95%UI)	Total n (95%UI)
All	**All**	17,962 (15,720, 19,736)	556 (-1,441, 2,510)	-1,814 (-2,076, -1,529)	10,227 (8,867, 11,307)	661 (494, 818)	22,150 (21,424, 22,676)	49,742 (42,988, 55,518)
Sex	**Female**	4,312 (3,678, 4,880)	-2,043 (-2,606, -1,336)	-2,071 (-2,130, -1,952)	4,625 (3,912, 5,246)	173 (121, 230)	7,008 (6,676, 7,285)	12,003 (9,652, 14,354)
	Male	13,650 (12,042, 14,855)	2,599 (1,164, 3,846)	257 (53, 423)	5,602 (4,955, 6,061)	488 (373, 589)	15,142 (14,748, 15,391)	37,738 (33,335, 41,165)
Age group	**15-34**	5,471 (4,677, 6,126)	126 (103, 148)	-67 (-71, -61)	158 (134, 179)	24 (19, 28)	6,198 (6,115, 6,265)	11,910 (10,978, 12,685)
	35-64	8,536 (7,558, 9,274)	1,994 (1,304, 2,580)	-614 (-760, -472)	5,272 (4,639, 5,754)	182 (147, 209)	12,063 (11,710, 12,301)	27,433 (24,598, 29,646)
	65+	3,954 (3,485, 4,336)	-1,563 (-2,849, -218)	-1,133 (-1,246, -995)	4,796 (4,094, 5,374)	455 (328, 580)	3,889 (3,599, 4,110)	10,399 (7,412, 13,187)

Distribution of alcohol-attributable DALYs by sex and age category

Figure 9 shows the number of DALYs by age group, sex and condition category. Prior to age 45, 'other' conditions and injuries comprised the majority of the alcohol-attributable DALYs for males and females, albeit with slightly different distributions. From age 45 onwards, cancers are the main cause of alcohol-attributable DALYs for females and a substantial contributor for males, along with cardiovascular disease, injuries and 'other' conditions. Almost all of the reduced risk of DALYs is concentrated in females aged 75-99. However, as mentioned in Table 9, at a population-level, almost all of this potential reduced risk is attenuated by cardiovascular conditions experienced by males between the ages of 45 and 75. For both males and females, a large proportion of alcohol-attributable DALYs are experienced between ages 45 and 64.

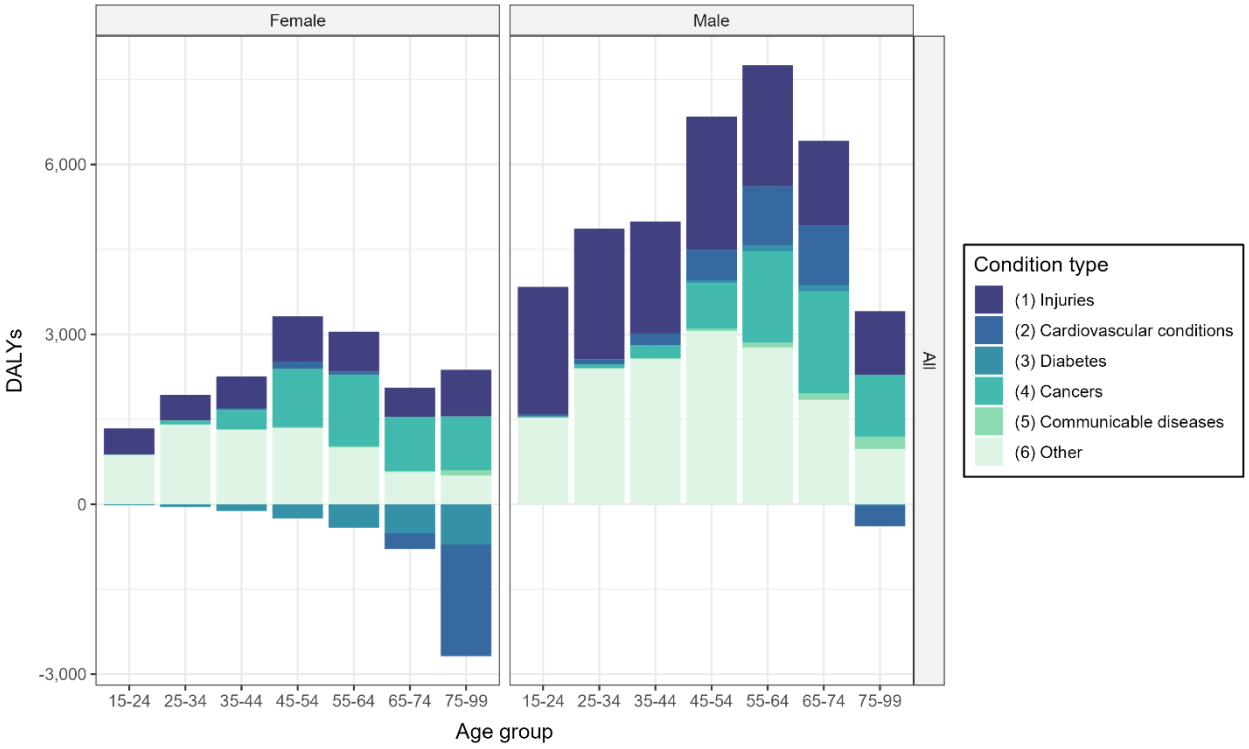

Figure 9. Alcohol-attributable disability-adjusted life years by condition category, sex and age

Proportion of DALYs attributable to alcohol for each condition

Figure 10 shows the number of total (dark blue) and alcohol-attributable (light blue) DALYs for each disease and injury condition. Alcohol use disorders contributed the most alcohol-attributable DALYs of any condition and are wholly attributable to alcohol consumption. Of all the cancers, colorectal cancer contributed the most alcohol-attributable DALYs followed by breast and mouth and neck cancers.

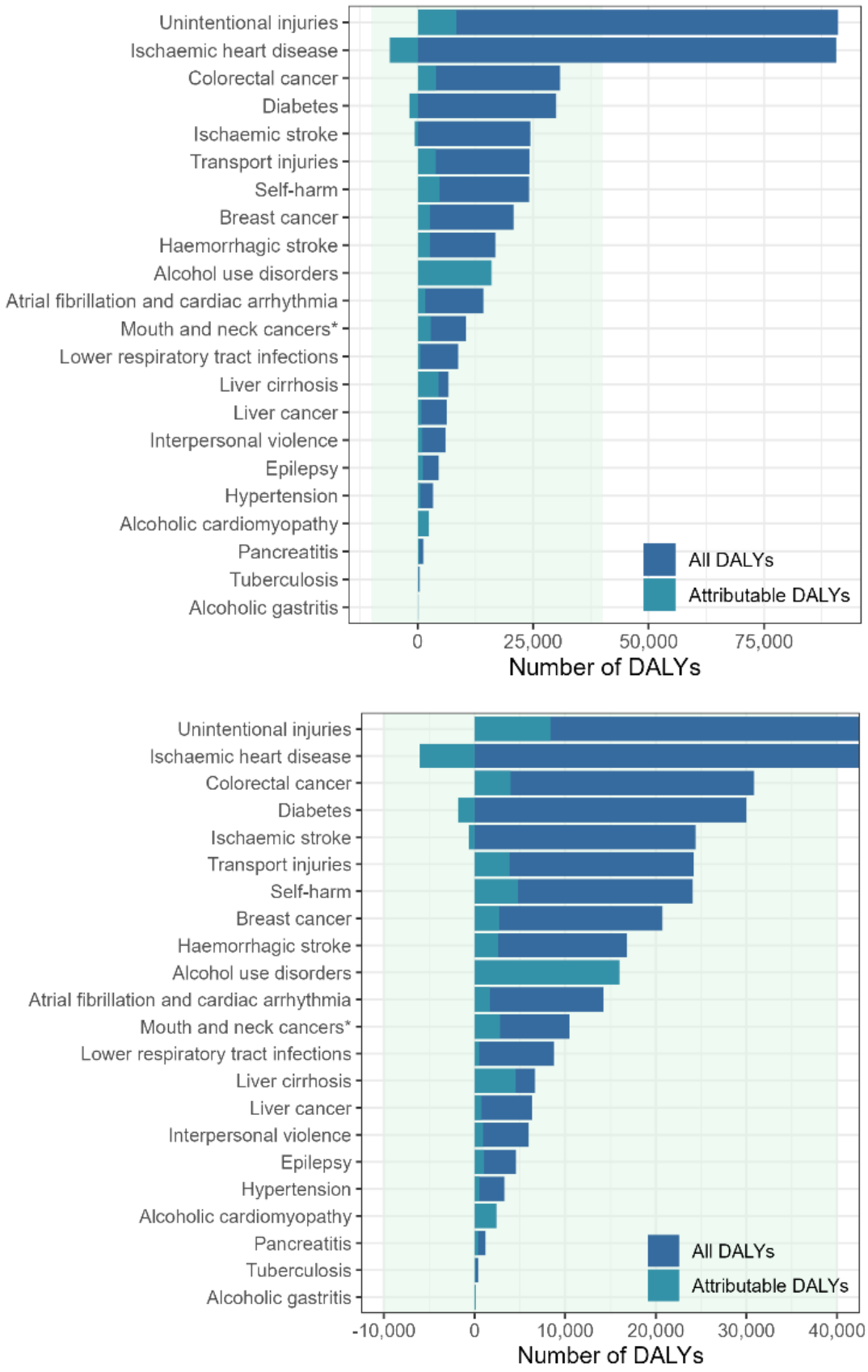

Figure 10. Number of total and alcohol-attributable DALYs by disease and injury condition (top) and magnified version (bottom)

Gross health impacts: assuming no protective effects

Table 10 presents the gross alcohol-attributable outcomes by demographic group and condition category. In total, there are 1,379 gross alcohol-attributable deaths (95%UI 1,202 - 1,528), an additional 478 deaths compared to the net estimate, which is comprised of an extra 420 deaths due to CVD and 59 deaths due to diabetes. There are an additional 2,202 hospitalisations (1,843 CVD; 359 diabetes) and 9,185 DALYs (7,095 CVD; 2,091 diabetes) in the gross estimates.

Table 10. Gross alcohol-attributable deaths, cancer registrations, publicly funded hospitalisations, DALYs and Accident Compensation Corporation (ACC) claims by demographic group (top panel) and condition category (bottom panel)

Demographic group		**Deaths** n (95%UI)	**Cancers** n (95%UI)	**Hospitalisations** n (95%UI)	**DALYs*** n (95%UI)	**ACC injury claims**** n (95%UI)
All		1,379 (1,202, 1,528)	1,250 (1,084 – 1,383)	31,484 (28,209 – 34,204)	58,927 (53,127, 63,597)	128,963 (114,324 – 140,681)
Māori	**Female**	63 (55 – 69)	87 (75 – 96)	2,178 (1,955 – 2,377)		5,971 (5,214, 6,613)
	Male	159 (144 – 169)	61 (54 – 65)	3,308 (2,989 – 3,546)		10,531 (9,471, 11,313)
Non-Māori	**Female**	389 (327 – 446)	574 (488 – 648)	9,738 (8,691 – 10,722)		42,707 (36,937, 47,778)
	Male	769 (676 – 844)	529 (467 – 573)	16,260 (14,574 – 17,559)		72,338 (65,004, 77,784)
Age group	**15-34**	100 (86 – 111)	17 (15 – 20)	7,647 (6,969 – 8,230)	12,035 (11,111 – 12,802)	42,067 (36,927, 46,303)
	35-64	472 (427 – 506)	642 (566 – 700)	13,963 (12,720 – 14,922)	29,536 (27,110 – 31,351)	65,849 (58,811, 71,309)
	65+	807 (689 – 912)	590 (503 – 663)	9,874 (8,520 – 11,052)	17,357 (14,906 – 19,443)	23,632 (20,888, 25,876)
Condition Group		**Deaths** n (95%UI)	**Cancers** n (95%UI)	**Hospitalisations** n (95%UI)	**DALYs*** n (95%UI)	**ACC injury claims**** n (95%UI)
Injuries		296 (257, 328)		12,766 (11,190 – 14,055)	17,962 (15,720, 19,736)	128,963 (114,324 – 140,681)
CVD		441 (394, 483)		3,550 (3,048 – 3,968)	7,651 (6,494, 8,637)	
Diabetes		7 (3, 11)		50 (21 – 81)	277 (128, 423)	
Cancer		376 (323, 420)	1,250 (1,084 – 1,383)	1,580 (1,373 – 1,744)	10,227 (8,867, 11,307)	
Communicable diseases		39 (27, 50)		1,773 (1,290 – 2,221)	661 (494, 818)	
Other***		220 (199, 236)		11,764 (11,287 – 12,135)	22,150 (21,424, 22,676)	

* DALYs by ethnicity were not available from the Global Burden of Disease Study.

** All included claims (89% of all ACC injury claims were included in the dataset provided by ACC).

*** 'Other' includes alcohol use disorders, alcoholic gastritis, epilepsy, liver cirrhosis, pancreatitis.

Discussion

Alcohol-attributable health burden in Aotearoa New Zealand

The net burden of alcohol-attributable disease and injury includes 901 deaths (95%UI 681 − 1104), 1,250 cancers (95%UI 1,084 − 1,383), 29,282 hospitalisations (95%UI 25,713 – 32,318); 128,963 ACC injury claims (95%UI 114,324 – 140,681) and 49,742 DALYs (95%UI 42,988 − 55,518) in 2018. Alcohol-attributable cancers were responsible for 376 deaths (95%UI 323 − 420); 1,580 hospitalisations (95%UI 1,373 − 1,744) and 10,227 DALYs (95%UI 8,867 − 11,307). Alcohol-attributable injuries were responsible for 296 (95%UI 257 − 328) deaths; 12,766 hospitalisations (95%UI 11,190 – 14,055); 128,963 ACC claims (95%UI 114,324 − 140,681) and 17,962 DALYs (95%UI 15,720 − 19,736).

The gross burden of alcohol-attributable disease and injury included 1,379 deaths (95%UI 1,202 - 1,528), 1,250 cancers (95%UI 1,084 − 1,383), 31,484 hospitalisations (95%UI 28,209 − 34,204), 58,927 DALYs (95%UI 53,127 - 63,597) and 128,963 ACC injury claims (95%UI 114,324 − 140,681) in 2018. As outlined in the methods, presentation of the gross alcohol-attributable disease and injury burden was required due to the contested nature of the evidence of potential protective effects of low-levels of consumption (including smaller effects over time and the moderating impact of binge drinking) and for comparability to other Aotearoa New Zealand AAF studies discussed in more detail below. The limitations of our gross estimate are also further discussed in the limitations section.

For Māori, net alcohol-attributable disease and injuries accounted for 4.7% of all deaths, 5.2% of all cancers, 3.4% of all hospitalisations, and 9.9% of all ACC claims, compared to 2.5%, 4.7%, 2.7%, and 8.7% for non-Māori, respectively. Standardised alcohol-attributable mortality, cancer registrations and hospitalisations were between 21% and 100% higher for Māori than for non-Māori, respectively. These inequities in alcohol-attributable disease and injury are consistent with previous AAF estimates in A-NZ[17,68], a Waitangi Tribunal claim (Health Services and Kaupapa Inquiry, Wai 2575)[80] and a specific Waitangi Tribunal report on tobacco, alcohol and other substance abuse.[22]

Comparisons to alcohol-attributable health burden estimates in Aotearoa New Zealand

Two other analyses of alcohol-attributable burden of disease in Aotearoa New Zealand have been conducted in 2000[17] and 2007. Each of these analyses estimated relatively similar alcohol-attributable mortality of 1,040 and 802 deaths representing 4.0% (of all ages) and 5.4% (of those under age 80) of all deaths. Both estimates reflect gross deaths (assuming no potential protective effects), which are comparable to our gross estimate of 1,379 deaths representing 4.2% of all deaths in 2018. The reported net deaths as a proportion of all deaths was 0.2% in 2000, 3.0% in 2007 (of all deaths of those under age 80) and 2.7% in this current study. Key differences between previous Aotearoa New Zealand estimates and our estimates include:

- **Updated evidence on the dose-response relationships between alcohol and disease used to calculate AAFs**. For example, the potential protective effects of lower levels of consumption for ischaemic heart disease calculated in the 2005 GBD study and the 2007 Aotearoa New Zealand analysis are substantially smaller than the 2016 GBD study estimate used in this study.

For example, comparing 2005 to 2016 estimates for ischaemic heart disease in men, the relative risk has increased at all levels of consumption: at 30g from 0.79 to 0.85; at 50g from 0.88 to 0.91 and at 90g 0.77 to 1.31. Likewise, the relative risks for breast and colorectal cancers are substantially higher in 2016 than in 2005 (e.g. colorectal cancer relative risk at 20g from 1.04 to 1.13; at 50g from 1.10 to 1.34; at 90g from 1.15 to 1.78) which are also the first and third highest causes of cancer mortality in Aotearoa New Zealand, respectively.[81] Consequently, previous AAFs likely underestimated the disease burden associated with conditions where the relative risks have substantially changed in line with new evidence.

Additionally, bespoke AAFs were created for some conditions including ischaemic heart disease and injuries in the 2007 analysis. For ischaemic heart disease, people consuming alcohol in heavy drinking occasions were defined as receiving no protective effect due to the independent adverse effects of binge drinking on heart health (see Appendix E from Connor, et al. (2013)[68] for more detail). For injuries, AAFs were derived from a population-based Aotearoa New Zealand case-control study of deaths and hospitalisations due to car crash injuries between 1998/1999, where alcohol was measured in drivers, and AAFs by self-reported ethnicity could be directly calculated.[82] As a result, many injury AAFs were substantially higher than those used in our current analysis. For example, AAFs for transport injuries were up to three times higher than those used in our analysis for some demographic groups. To gauge the magnitude of this difference, an imperfect comparison (because the age-groups do not match across studies) suggests using similar AAFs in our analysis would have increased alcohol-attributable transport deaths from 70 to 107 (a 50% increase). We opted to use the GBD relative risks throughout our analysis for consistency between conditions, for international comparability and to ensure a more streamlined approach for generating AAF in the future (i.e. with an updated version of InterMAHP). Further, the Aotearoa New Zealand-derived relative risks for traffic injuries were based on a study from 1998/1999,[82] which may not reflect contemporary alcohol-related driving and traffic injuries given changes in drink driving counter-measures since that time.[41]

- **Different sources for alcohol consumption measures.** In our analysis, we have used updated and different alcohol consumption figures compared to previous reports. First, alcohol available for consumption according to Stats NZ has decreased on a per capita basis from 2.17 to 1.96 drinks per day (a 16% decrease) and was used in our analysis. Second, our analysis assumed that ex-drinkers had the same risk/consumption as never drinkers because this was a constraint of using GBD relative risks in InterMAHP, however, the 2007 analysis assigned ex-drinkers the same risk as the low-consumption group. Third, the 2007 analysis used a categorised alcohol consumption measure which used the mid-point of each category to align with the relative risk functions used in that study, while our analysis used an established distribution from international literature around the average consumption to produce a continuous distribution consistent with contemporary GBD relative risk functions.
- **Selection of different populations.** First, the 2007 cohort only included only those aged under 80, while our cohort included all age groups aged over 14. Those over 80 had been excluded on the basis of the poor quality of Aotearoa New Zealand consumption data for this

age group, the small proportion of Māori, and the distortions that would be caused by the large estimated benefits in the oldest groups based on unconvincing data. Given the uncertainties, the investigators did not consider that deaths delayed in the group over 80 should be interpreted as offsetting deaths among younger people in which Māori are overrepresented.[83] If we examine just deaths of those between age 15-74 (our closest comparable age group to under 80), the estimated gross alcohol-attributable deaths are reduced from 1,379 to 858 (38% decrease) but the proportion of alcohol-attributable deaths increases from 4.2% to 7.2% of all deaths for those aged 15-74 in 2018 (11,844 total deaths). As a result, in our analysis, alcohol-attributable mortality contributed 4.2% (gross) and 2.7% (net) of all deaths among those aged over 14; but if our analysis was limited to those aged 74 and younger, this would increase to 7.2% (gross) and 6.2% (net). Second, there has been a 16.5% increase in the number of total deaths (due to any cause) from 28,521 in 2007 to 33,225 in 2018.[84] Thus, even if alcohol consumption and the relative risk estimates remained the same as in 2007, we would expect an increase in the absolute number of alcohol-attributable deaths overtime. This is accounted for in the population proportion results (e.g. 5.4% of all deaths in Connor, et al. (2013)[68]compared to 4.2% in this current study).

Strengths and limitations

The study had a number of strengths that include using the most up to date relative risk estimates (at the time) for 26 alcohol-attributable disease and injury conditions. The use of GBD risk estimates improves comparability with AAF studies from other jurisdictions and potentially over time in Aotearoa New Zealand. As such, this approach can be replicated relatively easy as the evidence base is updated (both in relation to relative risks and domestic alcohol consumption), which lays the groundwork for monitoring alcohol-related harm over time. The current study also leveraged a number of routinely collected data sources to examine a range of different health-related outcomes (e.g. deaths, cancer registrations, hospitalisations, ACC claims and DALYs) which better captures the full extent of alcohol-related health harms at a population level but also facilitates the attribution of these harms (e.g. to the health sector or ACC).

Our analysis was limited to those health harms with appropriate dose-response relationships identified in the GBD study. Consequently, our results do not consider the health consequences of FASD, sexually transmitted diseases, or other social harms (e.g. relationship and workplace problems). For example, it is estimated that in Aotearoa New Zealand in the 2018/2019 year, FASD prevalence was 1.3% (95%CI 0.9 - 1.9) and that 776 (95%CI 492 - 1,112) children are born with FASD each year.[4] Similarly, we do not consider the wider harms of alcohol-attributable crime, lost productivity or harms to others, which can also impact health. Our analysis also does not include other measures of health loss such as utilisation of secondary and community mental health and addiction treatments. Relatedly, our analysis takes a Western and individualistic approach to harm which largely ignores the impacts of the individual health harms on the wider whānau or its intergenerational consequences.

Another limitation is related to the comparative risk methodology in general. The results of this analysis reflect the evidence at one point in time (2016 for relative risks in this study) from a single

meta-analysis (GBD relative risks). As a result, we have included the contested evidence of reduced risk of lower alcohol consumption on diabetes, ischaemic heart disease and ischaemic stroke. In 2023, a meta-analysis conducted by the Canadian Centre on Substance Use and Addiction observed no statistically significant protective effect of lower levels of alcohol use for ischaemic heart disease.[34] InterMAHP only uses GBD or WHO relative risks to compute AAFs, which were last updated in 2016 and may include differences in systematic review and meta-analysis methodology than more recent reviews. As mentioned, if we assumed no protective effects of low alcohol consumption, 1,379 deaths, 31,484 hospitalisations and 58,927 DALYs would be attributable to alcohol in 2018. An additional limitation of the comparative risk methodology is that relative risk functions are generated from combining evidence from multiple jurisdictions, which may not be valid in the Aotearoa New Zealand context. This issue was highlighted by the differences in alcohol-attributable transport injuries in the 1998/1999 study compared to the international relative risks at that time.

We also used the GBD risk estimates because they aligned better with other data sources and enable comparability between this study and other Aotearoa New Zealand and international research that use GBD methodologies. The GBD risk relationships were also updated more recently than the WHO set, and reflect ongoing evidence developments in the estimation of relative risk functions for alcohol-attributable disease and injury. However, a 2019 analysis showed that GBD risk estimates result in a much larger potential protective effect for ischaemic heart disease than WHO risk estimates. Specifically, the analysis found that using the WHO risk function for ischaemic heart disease instead of the GBD risk function resulted in a substantial increase in the number of alcohol-attributable deaths for the Canadian (GBD only = 2,933; GBD + WHO for IHD = 3,901; difference 968 or 33% higher) and Australian (GBD only = 5,179; GBD + WHO for IHD = 6,454; difference 1,275 or 25% higher) populations. Thus, because ischaemic heart disease is a major contributor to overall mortality and morbidity, risk function selection can have a large impact on the overall results.

We have conservatively opted to present the net outcomes as our main analysis rather than the gross outcomes. Presentation of the net outcomes implicitly assumes an equivalent level of certainty in the relative risk estimates across conditions, which is not the case. For example, the relationship between alcohol and cancer is well established with the International Agency for Research on Cancer classifying alcohol as carcinogenic to humans (Group 1).[2] In contrast, as discussed throughout this report, the evidence of any potential protective effects is highly contested and is becoming less convincing as new, more methodologically robust studies have emerged. A second limitation of the net effects is that the harms and potential benefits do not accrue in the same individuals, so harms cannot offset benefits (because less heart disease is not a benefit if you are killed by an alcohol-attributable car crash at age 25). There are also limitations in our gross outcome estimate whereby we only excluded potential protective affects in subgroups (age, sex, ethnicity) that had an overall protective effect. This means that all other subgroups for those three conditions with potential protective effects, some protective effects are still included in the overall estimate (e.g. an AAF of 0.066 for ischaemic stroke for Māori males aged 65-74 would include protective effects from individuals with lower consumption within this subgroup).

There is an implicit assumption within the AAFs that the consumption level at the age of analysis (e.g. alcohol consumption at age 60) is representative of consumption throughout the life course. As such, people who have consumed large amounts of alcohol in younger cohorts (e.g. at age 25) are assumed to have only the risk associated with their current drinking. A similar assumption built into our analysis is that ex-drinkers have the equivalent risk of an alcohol-attributable condition as a never drinker as GBD relative risks do not disaggregate these drinker categories. Both these assumptions are likely to underestimate the total alcohol-attributable burden of disease as alcohol consumption is generally higher at younger ages and people who have stopped drinking have often done so due to other health complications (which could have been caused or exacerbated by past alcohol consumption).

Our analysis grouped non-Māori into a single homogenous category due to data availability, which could mask major inequities in the current burden of alcohol-related harm for this group. For example, this grouping ignores the substantial harms experienced by Pacific people[85] and does not allow for direct comparisons between individual ethnicities. Unfortunately, further segmenting the datasets by ethnicity was deemed infeasible due to very low Pacific and Asian numbers and the associated risk of highly variable and unstable estimates.

There were also a number of limitations relating to the outcome data used in this analysis. First, ACC estimate that the current dataset reflects around 89% of all claims (excluding work-related gradual process, treatment injury, accredited employers' programme and public health acute services claims), so our estimate of alcohol-attributable injuries is likely conservative. Second, ACC claims are not classified by ICD codes so it is possible some more severe injuries (e.g. non-vehicle related transport injuries) were coded as unintentional injuries. Third, merging of multiple datasets was required for hospitalisation data which likely led to some double counting (an estimated 2.8%, see supplementary methods for more detail). Fourth, Māori are consistently under-represented in health data which leads to undercounting and mis-representation of health need and burden.[86] Our reliance on publicly available datasets may mean we are significantly underestimating the alcohol-attributable health burden experienced by Māori.

We did not conduct the analysis at smaller spatial scales (e.g. by region) due to the lack of accurate estimates of geographic differences in alcohol consumption. It is possible that there are inter-regional differences in alcohol consumption, and therefore, different alcohol-attributable fractions for each condition. Even if alcohol consumption data were available, any disaggregated analysis would be based on an implicit assumption that people in those areas had resided there for a substantial portion of their life (to contribute to chronic conditions such as cancer). However, we acknowledge that many end/next users may want to use the AAFs to calculate harms in their local area/context. As such, we have produced a short guide on how to apply the AAFs sub-nationally and the key assumptions that should be acknowledged with such an analysis (see supplementary material user guide – SM1).

The implications of alcohol-attributable health burden

In addition to substantial social impacts of losing family to an alcohol-attributable disease or living with an alcohol-attributable disability, there are wider system pressures due to the alcohol-attributable health burden. The health system is under significant pressure across multiple areas

including staffing, resourcing and treatment availability. In 2023, 5,614 people were waiting over 12-months for planned care (up from 4,200 in 2022) due to system capacity issues.[87] We estimated that 29,282 hospitalisations (2.8% of all hospitalisations) in 2018 were attributable to alcohol which would have detracted from the provision of core services. For example, central region hospitals (Wellington Regional Hospital, Hutt Valley Hospital and Kenepuru Hospital) in 2018 completed 67,000 hospital discharges,[88] meaning that nationwide, the equivalent of half of the Wellington region's hospital capacity was dedicated to alcohol-attributable admissions. National cancer treatment performance metrics were below their targets for the year 2022-2023 (31 -day measure 84.9% compared to 85% target; 62-day measure 80.1% compared to 90% target), with lower performance for Māori and Pacific compared to overall non-Māori, non-Pacific,[89] suggesting cancer treatment is reaching its system capacity. Alcohol-attributable cancer mortality is estimated at ~3.5% of all cancer deaths. However, for some prevalent cancers, alcohol is a substantial contributor (11.9% for colorectal cancer; 12.6% for breast), while for some rarer cancers, alcohol is one of the main contributors (42% for lip and oral cancers; 45% for nasopharyngeal cancer).

For ACC claims, using publicly available estimates of the average 2018-inflation adjusted claim cost within each injury category (unintentional injury = $1,883;[90, p.28] traffic injuries $10,563;[90, p.28] self-harm and interpersonal violence = $56,706[91, p.29]), the estimated annual 2018 inflation-adjusted cost of alcohol-attributable claims to ACC would have been: $287m for unintentional injuries; $54m for traffic injuries; and $56m for self-harm and interpersonal violence injuries. Note these crude estimates only include the cost to ACC for that year for new claims and do not include the lifetime costs of ongoing support. A 2021 analysis by the Helen Clark Foundation of ACC alcohol-attributable crash data from 2016 to 2020 revealed the lifetime cost of alcohol-related crash injuries was on average $233m per year,[92] substantially higher than the crude estimate above of $54m. Collectively, this crude analysis suggests alcohol-attributable injuries could be costing ACC an estimated ~$500m each year (depending on the figure used for traffic injuries), which is equivalent to the yearly cost of all motor vehicle ACC injury claims ($474m). Motor vehicle injury claims have justified their own separate account within ACC and a dedicated levy imposed on drivers (via vehicle registrations) and on petrol to cost-recover for that account. Based on cost-recovery principles, there may be scope to recover the costs incurred by ACC due to alcohol-attributable claims from those who contributed to those claims (e.g. drinkers and/or the alcohol industry) via a specific levy on alcohol (note this is the opinion of the authors and does not reflect ACC policy).

Alcohol-attributable conditions place a substantial financial burden on the health system. An Aotearoa New Zealand costing study estimated that the 2018 inflation-adjusted cost to the health system for cancer treatment was $3.3bn (inflation adjusted and converted from US to NZD 2018 value) and for cardiovascular disease $4.4bn.[93] If we apply our AAFs to these figures we calculate an estimated $162m for alcohol-attributable cancer treatment and $171m for CVD for a total of ~$300m without costs of wholly attributable alcohol conditions (e.g. alcohol use disorders), communicable diseases or injuries. A previous Aotearoa New Zealand costing study based on the 2005/2006 population estimated health system costs at $298m ($374m 2018 inflation-adjusted).[94] While these figures should be interpreted with caution, they provide an indicative magnitude of the health sector costs that could be directly incurred via alcohol-

attributable conditions. Future research should attempt to conduct an updated comprehensive costing study of alcohol-attributable disease and injury.

Options for reducing the alcohol-attributable health burden

Population-based approaches are required to reduce alcohol-related harm. Alcohol-related harms are not isolated to a subgroup of high-risk individuals. For example, an estimated 13.3% of all alcohol-related cancers in Europe (23,000 cancer cases) occur at consumption below 20 g per day (140 g per week) each year.[29] Extrapolating this to the Aotearoa New Zealand context (assuming similar levels of low-risk drinking), consumption below 140 g per week (Aotearoa New Zealand guidelines for men = 150 g, women = 100 g) could be responsible for 50 cancer deaths and 180 cancer registrations each year. Table 11 demonstrates an individual's risk of several conditions at different thresholds of alcohol consumption below the current Manatū Hauora low-risk drinking guidelines. Importantly, at an individual level, a person's risk of developing severe alcohol-related conditions is realised well before any potential benefits for ischaemic heart disease (e.g. after age 65). For example, a female who has consumed on average under half the Manatū Hauora low-risk drinking guidelines for her entire life (50 g per week) may have a 13% reduced risk of ischaemic heart disease, but will also have a 5% increased risk of colorectal cancer, 10% increased risk of breast cancer and 5% increased risk of unintentional injury.

Table 11. Global Burden of Disease (GBD) study relative risks of colorectal cancer, breast cancer, unintentional injury and ischaemic heart disease at different thresholds of weekly alcohol consumption

Weekly alcohol consumption[1]	**Colorectal cancer** relative risk (95%CI)	**Breast cancer** relative risk (95%CI)	**Unintentional injury** relative risk (95%CI)	**ischaemic heart disease (women)** relative risk (95%CI)
Zero alcohol	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Two drinks (20g)	1.02 (1.01, 1.03)	1.04 (1.01, 1.09)	1.02 (1.00, 1.05)	0.95 (0.92, 0.98)
Five drinks **(**50g)	1.05 (1.02, 1.07)	1.10 (1.02, 1.18)	1.05 (1.01, 1.11)	0.87 (0.81, 0.95)
Seven drinks (70g)	1.07 (1.03, 1.11)	1.14 (1.05, 1.24)	1.08 (1.01, 1.17)	0.82 (0.72, 0.93)
Ten drinks (100g)	1.09 (1.04, 1.14)	1.18 (1.08, 1.27)	1.10 (1.02, 1.22)	0.83 (0.72, 0.94)
15 drinks (150g)	1.14 (1.06, 1.22)	1.25 (1.15, 1.35)	1.15 (1.03, 1.32)	0.84 (0.73, 0.97)

[1] Two drinks = Canadian Centre on Substance Use and Addiction low risk drinking guideline; five drinks = half Manatū Hauora low-risk drinking guideline (women); seven drinks = less than half Manatū Hauora low-risk drinking guideline (Men); ten drinks = Manatū Hauora low-risk drinking guideline (women); 15 drinks = Manatū Hauora low-risk drinking guideline (men).[30]

The roadmap to reduced alcohol-related harm is clear. The WHO's SAFER initiative identifies highly effective strategies for governments to adopt.[35] Given it is likely that a substantial amount of this burden is associated with drinking around or below the low-risk drinking guidelines, a focus on addressing alcohol availability, marketing and price is preferable to individual-focused interventions on drink driving or brief interventions. Aotearoa New Zealand modelling suggests substantial potential health gains (>700,000 health-adjusted life years) are possible from a package of interventions on alcohol tax, availability and marketing.[32] Based on available evidence,

each one of the modelled interventions could each bring relatively similar amounts of health gain (~200,000 health-adjusted life years).[32] The 2010 Law Commission[45] and subsequent reviews[53,54] recommended increasing tax by at least 50% and phasing out alcohol sponsorship of sport. Given the substantial economic burden of alcohol-related harm on Government services (e.g. ACC ~$400m and health >$400m alone), there is scope for recovering these costs. Section 101 of the Pae Ora (Healthy Futures) Act 2022 permits Manatū Hauora to recover the costs it incurs in addressing alcohol-related harm and in its other alcohol-related activities via a levy.[95] Similarly, an amendment to the Accident Compensation Act 2001 could enable the ACC to cost recover for alcohol-attributable ACC claims.

Targeted interventions still offer opportunities to reduce alcohol-related harm. While a population shift in alcohol consumption is required to substantially reduce the overall burden of alcohol-related harm, targeted interventions are still required to address issues at the severe end of the harm scale. We estimated alcohol use disorders alone were attributable for 53 deaths; 4,520 hospitalisations and 15,983 DALYs in 2018. Brief interventions can help identify and reduce the alcohol consumption of those drinking above low-risk guidelines[43] and can be cost effective.[42,44] Given there is no systematic or funded brief intervention programme in Aotearoa New Zealand, there is substantial opportunity to reduce alcohol consumption via a well-coordinated and funded national brief intervention programme as recommended by the Law Commission in 2010.[45] Further, there is already a brief intervention model that has been implemented in Aotearoa New Zealand that could be scaled if appropriately funded.[46] In the context of the Pae Ora Act, there may be scope to increase the alcohol levy to recover the costs of such a programme. However, brief interventions should be considered in the context of the broader alcohol environment as their efficacy is likely to be reduced if environmental determinants of alcohol consumption (e.g. tax, availability and marketing) remain unchanged.

Our analysis estimated alcohol-attributable transport injuries were responsible for 70 deaths; 2,492 hospitalisations; and 4,245 ACC injury claims in 2018 placing a substantial health and financial burden on society. As noted above, this is a conservative estimate and could be up to 50% higher if we used the same relative risks as previous Aotearoa New Zealand AAF studies. In 2019, the Ministry for Transport estimated that the average social cost per crash fatality was $4.5m and serious injury was $0.5m.[96] These costs include lost productivity, loss of quality of life, pain and suffering as well as the tangible costs of treating an injury, but 90% of the costs are made up of loss of life and life quality. Using these figures, the social cost of alcohol-attributable vehicle deaths would be $315m and alcohol-attributable vehicle hospitalisations $1,246m in 2018. As mentioned above, the average yearly cost of alcohol-related crashes to ACC was estimated at $233m between 2016 and 2020 (treatment and income support).[92] Despite the enormous burden of alcohol-attributable vehicle injuries, there may be less scope to reduce these via targeted policy intervention, as Aotearoa New Zealand currently has drink driving counter-measures that are largely in line with WHO recommendations.[41] Further, analysis of blood alcohol levels of drivers involved in a vehicle crash resulting in a fatality or hospitalisation suggests ~6% of crashes occur in people with alcohol present but below the legal limit.[41] This is consistent with an Aotearoa New Zealand study that observed a 3.2 times (95%CI 1.1 - 10.0) increased risk of being involved in a crash causing a fatality or hospitalisation for those with a blood alcohol concentration below the legal limit (3-50 mg/100 mL) compared to those with less than 3 mg/100 mL.[82] This suggests that a key lever

to reducing alcohol-attributable traffic injuries is through a population shift in alcohol consumption via restrictions on marketing, availability and price as well as additional targeted interventions.

Strategic coordination is required to address alcohol-related harms. The last National Alcohol Strategy was published by the Manatū Hauora in 2003. Consequently, strategic government action on alcohol-related harm has largely relied on a collection of broader policies from different government agencies (e.g. Ministry of Social Development strategy for youth offending or Ministry of Justice strategy for reducing violence) rather than a dedicated alcohol strategy. The strength of a dedicated national alcohol strategy is that it would bring together different partners, identify their contributions and responsibilities under shared objectives and goals, and ultimately hold the Government to account by benchmarking performance against the strategy.

Te Tiriti-based alcohol legislation and strategy are required to address health inequities. Māori experience disproportionate alcohol-related harms,[80] which the Crown has failed to address.[22] Most recently, an Aotearoa New Zealand modelling study estimated that Government inaction on key recommendations by the Law Commission resulted in a total of 1,300 health-adjusted life years lost by Māori.[97] Our AAF results suggest there are still substantial inequities in the alcohol-related health burden between Māori and non-Māori that include a standardised rate of alcohol-attributable mortality that was twice that of non-Māori, with some conditions having a mortality rate three or four times higher. These inequities cannot be addressed without a substantial shift towards a Te Tiriti-based approach to alcohol legislation and strategy. Maynard (2022)[67] outlines four key features of future alcohol policy to ensure it is Te Tiriti o Waitangi-compliant: 1) Te Tiriti o Waitangi is specifically referred to and references are precisely worded; 2) Māori can meaningfully and effectively participate in decisions around alcohol in their communities; 3) inequities between Māori and non-Māori are actively addressed; and 4) monitoring systems ensure progress on eliminating health inequities. Section 6 of the Pae Ora Act outlines requirements and actions for the Crown's intention to give effect to Te Tiriti. The Pae Ora Act also introduced Iwi-Māori Partnership Boards tasked with informing health system decisions and facilitating greater partnership in the development and delivery of programmes. Section 6 also includes a requirement for the Minister of Health and the health entities (i.e. Te Whatu Ora, Manatū Hauora) to uphold health sector principles, which includes improving Māori health outcomes. However, the health sector is somewhat legislatively constrained in relation to alcohol policy as key legislation sits with other Government agencies (e.g. Justice, Customs). Consequently, all alcohol policy should be held to at least the same standard as the Pae Ora Act, which would be a starting point for ensuring alcohol policy is more Te Tiriti compliant.

Monitoring of alcohol-related harm and alcohol use. A limitation to addressing alcohol-related harm is reliance on imperfect or incomplete routinely-collected information on the full range of potential alcohol-related harms. The AAF analysis provided in this report provides a replicable methodology for assessing a large range of health harms. However, from a health perspective, this analysis is still challenged by: limited information on alcohol use and drinking patterns, particularly at a sub-national level; limited information for some key alcohol-attributable conditions (e.g. FASD); or localised data on alcohol-attributable events (e.g. consistent reporting of alcohol in emergency department, ACC or police crash investigation data). Further, health burden is only one

aspect of alcohol's wide range of harms but data on alcohol-related crime, lost productivity and harm to others is limited or difficult to access. There is a strong rationale for a centralised and systematic approach to collating data from different Government agencies to create a national monitoring system for alcohol-related harms. Such a system could also help improve and standardise the reporting of alcohol-related events across different agencies.

Conclusion

In summary, alcohol caused a substantial preventable health burden in 2018 via a range of disease and injury conditions. The health burden from alcohol was disproportionately borne by Māori and males. Cancers, injuries and wholly attributable alcohol conditions (e.g. alcohol use disorders) contribute the large majority of alcohol-attributable mortality and morbidity. Our estimates are conservative for a number of reasons including: assuming there are potential protective effects of low-level consumption; the inability to include the full range of alcohol-attributable conditions (e.g. FASD); the GBD relative risks used in this analysis produce estimates ~25% lower than WHO relative risks. Direct alcohol-attributable heath impacts place a substantial economic burden on individuals and the Government. Given the current policy landscape in Aotearoa New Zealand and international best practice; restrictions on alcohol marketing and availability, increases to excise tax, and implementation of a national screening and brief intervention programme are potentially effective policy avenues for reducing the alcohol-attributable health burden.

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