Binge Drinking

Acute Consequences and Lasting Impacts

ALCOHOL AND SOCIETY 2026

A REVIEW OF INTERNATIONAL AND SWEDISH RESEARCH

by Harold Holder, Tim Naimi, Tim Stockwell, Sven Andréasson, Tanya Chikritzhs, Frida Dangardt

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Contents

Executive Summary

- Binge drinking is typically defined as drinking 5 or more drinks per occasion. This is sometimes modified to 4 or more drinks per women or may be defined by grams of ethanol (e.g., 60 grams) given the variability in standard drink sizes internationally.
- In recent decades overall levels of binge drinking in Sweden, Norway and Denmark have been steady at between 30 and 35% but with some divergent trends by age and gender.
- While the major contribution to road crashes, violence and poisoning (i.e., acute effects) is widely understood, the enduring effects of binge drinking on dementia, alcohol dependence and chronic disease in later life are largely overlooked.
- Rapid alcohol use on a binge drinking occasion overwhelms the body's ability to process alcohol, leading to oxidative stress and to an increase in acetaldehyde, a dangerous metabolite and a major carcinogen.
- The body's increased exposure to high blood alcohol concentrations, to acetaldehyde concentrations and to oxidative stress leads to impairments in the short-term and risks enduring toxic and carcinogenic impacts on all organs.
- The extent of binge drinking is largely underestimated. Among people who drink within 'moderate' levels on average (e.g., up to one or to drinks per day), the majority also engage in occasional binge drinking.

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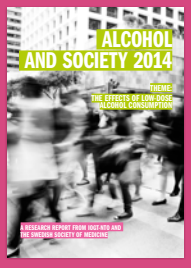

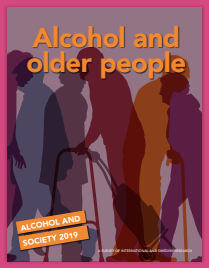

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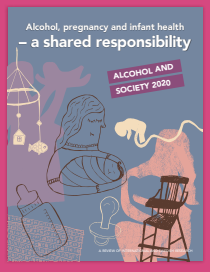
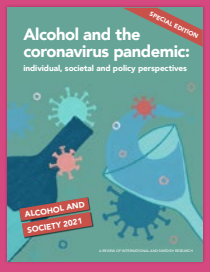
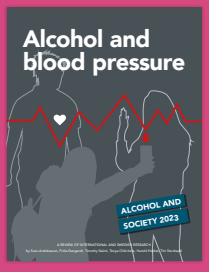
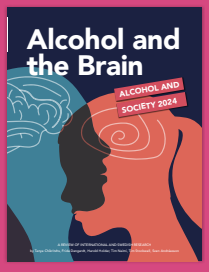
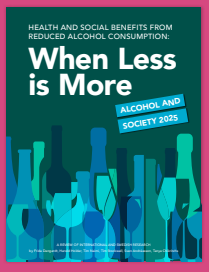
- Rates of binge drinking decline and fall with total alcohol consumption in a population. This is because 5+ drinking occasions account for a at least half of consumption in high income countries such as Sweden. As a result, policies that reduce total consumption also reduce rates of binge drinking and related harms.
- Fortunately, there are many effective strategies that reduce binge drinking and its consequences, including for those with established or early-stage alcohol use disorders. Examples of effective population-level policies include higher alcohol taxes, minimum unit pricing, restrictions on sales hours, reduced outlet density, marketing limits, minimum drinking age laws and , drink-driving enforcement, and liability laws for serving intoxicated patrons.
- Effective interventions for individuals include brief counselling in health care settings, medications, treatments for alcohol use disorder and use of devices such as ignition interlocks and alcohol detection systems in cars (that reduce drink driving).
- A cultural shift in societal norms and attitudes towards binge drinking throughout Sweden and other Nordic countries is in order. Future nutritional guidelines could include specific recommendations for avoiding binge drinking, in addition to recommended limits for total consumption.











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She has qualifications in epidemiology and biostatistics, some 20 years experience in alcohol research and a national profile as an expert in her field. Her research covers many areas of alcohol policy and alcohol epidemiology, such as alcohol consumption, alcohol related harms, alcohol taxation, liquor licensing, alcohol and heart disease, and alcohol and cancer.

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Recently Dr. Holder chaired an international research group in an evaluation of Swedish research on alcohol, narcotics, doping, tobacco and gambling for the Swedish Council for Working Life and Social Research. The evaluation report was published in 2012.

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Tim Stockwel is a Fellow of the Royal Society of Canada and past recipient of the 2013 international E.M. Jellinek Memorial Award for Outstanding Research on Alcohol Policy.

1 Introduction: What is binge drinking and why is it a problem?

Binge drinking is defined as the fast consumption of large volumes of alcohol. Alcohol use in general and binge drinking in particular contribute to a variety of medical, social and economic outcomes. It is critically important to understand the relationship between alcohol use (i.e., the dose of ethanol) and these outcomes. Alcohol use is measured in several ways. The most common ways are to measure total use of alcohol at a population level per person (usually 15+ years) and average use per person, (e.g, number of drinks per day). Most studies of the impacts of alcohol consumption are based on total use measures or their derivatives.

However, patterns of use are also critically important, but are under-appreciated and are perhaps not coincidentally, under-studied. Patterns of use relate to how alcohol use is clustered over time – namely how much alcohol is used per day and/or per drinking occasion and also how frequently alcohol is consumed. The amount one consumes when actually drinking is referred to as "per-occasion" consumption. Even within a particular level of average consumption, there is great variability in terms of how different people spread out their drinks over time. For example, a person who drinks 7 drinks per week on average may have just one every day or all 7 on one drinking occasion. As will be shown later in this report, in most countries at least half of all alcohol purchased for consumption in a country is actually consumed in a binge drinking pattern.

Higher per-occasion consumption correlates closely with the degree of impairment from alcohol from a high blood alcohol concentration (BAC). Alcohol impairment refers to an acquired inability, or decrement in ability, to perform cognitive and physical tasks. Binge drinking (also referred to as 'heavy episodic drinking'), is a common threshold of per-occasion consumption used in research which typically results in BACs of 0.8‰ (0.08%) or greater. Such a BAC will be achieved by the average male after consuming 6 standard drinks (= 72g of ethanol in Sweden) and 5 standard drinks by a female of average weight. However, while this is a useful threshold, it is important to understand that decrements in impairment begin below BAC levels that typically are encountered at the binge drinking threshold.

In North American research, binge drinking is usually defined as the consumption of four or more drinks in one day for a woman and five or more for men with one "drink" defined as containing approximately 14g of pure alcohol. Some researchers also employ

In most countries at least half of all alcohol purchased for consumption in a country is actually consumed in a binge drinking pattern.

The term intoxication refers to situations in which there is visible (to others) or subjective (to the drinker him or herself) effects of alcohol. However, objective measures of impairment begin well before intoxication is apparent.

a stricter, more time-limited definition where these amounts are consumed within two hours, a time limit required to reach a BAC level of 0.8‰ (0.08%). The sex difference in the definition is intended to reflect the finding that females typically obtain higher blood alcohol concentrations in experimental studies from a fixed alcohol dose compared with males by virtue of lower bodyweight and slower metabolism.

Another tradition found in European and international research is to define binge drinking as the consumption of four or more standard drinks for both sexes. In Sweden this amounts to 48g of ethanol in a day, a threshold inspired by recent Australian drinking guidelines, which were even lower, at 4 or more 10 g standard drinks. It is reasoned variously that bodyweight rather than sex is the principle reason for individual variations in blood alcohol concentrations and, as well, females tend to drink alcohol at a slower pace than males.

In the present report we recognise that there is no risk-free level of alcohol use and that injury risk increases after consumption of just one or two drinks and proceeds with an exponential increase in risk at higher levels (e.g. [1]). The definition of exceeding 60g of ethanol during a drinking occasion will be our default in this report as it is both widely used and provides an effective contrast between higher and lower risk drinking patterns. We will, however, note exact definitions used in key studies we describe in this report. Again, we note all of these precise-sounding thresholds are somewhat arbitrary as there is an underlying continuum of risk that starts with any alcohol use and which then increases rapidly with increasing consumption and BAC level.

The term intoxication refers to situations in which there is visible (to others) or subjective (to the drinker him or herself) effects of alcohol. However, objective measures of impairment begin well before intoxication is apparent. In other words, everyone who appears intoxicated is impaired, but not everyone who is impaired is intoxicated.

High per-occasion consumption, particularly above the family of thresholds used to define binge drinking described above, is the key risk factor for "acute" outcomes such as unintentional injuries, interpersonal violence and social problems including child abuse and neglect, and crimes such as vandalism and assault. However, per-occasion consumption also increases the risk for a range of chronic diseases such as heart attacks, strokes, diabetes and dementia, and modifies relationships between average consumption and chronic disease outcomes. This contribution of binge drinking to chronic disease comes in two forms: first, binge drinking occasions constitute a large fraction of total consumption in the population; and second there may be BAC-related damage when high BACs overwhelm physiological protective mechanisms (see Section 2).

The risks from high per-occasion consumption varies by age. Youth and young adults have rapidly developing brains, higher levels of impulsivity and, usually, low tolerance and so are particularly vulnerable to alcohol's effects. In addition to being a risk factor for a variety of acute and chronic diseases, binge drinking in younger years is a very strong risk factor for the subsequent development of an alcohol use disorder (AUD). Virtually all persons with an AUD engage in binge drinking and/or have high BACs. Furthermore, it has been shown that an inability to stop drinking after two drinks is one of the earliest signs of a developing alcohol use disorder.[2]

There are also sex and gender considerations. Men generally have a higher prevalence of binge drinking compared to women, and drink more during binge drinking occasions. Women generally weigh less and metabolize alcohol more slowly, so a comparable amount of alcohol might lead to more impairment among women. Social expectancies and other factors may also alter the drinking context and risk – women may be at more risk of harms in terms of victimization in terms of interpersonal violence, including sexual aggression, or consequences related to, for example, unintended preg-

nancy. On the other hand, men may act more aggressively or impulsively leading to more adverse consequences for themselves and others, particularly with respect to violence and unintentional injuries.

In this report, the focus will be on describing patterns of per-occasion consumption and reviewing relationships between per occasion consumption and a variety of health and social outcomes. Because of its widespread use in the population, role as a powerful risk factor for multiple acute and chronic medical conditions, binge drinking might well be framed as perhaps the highest priority for prevention and public health interventions around alcohol and health. It is important to further emphasise the enduring impacts of binge drinking across the life-course as a result of more intense exposure to toxic and carcinogenic effects of high BAC drinking episodes, especially when drinking speed is above one drink per hour. We therefore conclude the report with evidence-based recommendations about how to prevent or reduce per-occasion consumption amongst individuals and within the general population.

BOX 1

This report, as with all others, is undertaken in two major steps. First, an extensive search is completed to identify relevant published science. Second, the search results are reviewed and summarized. This is done by in-person discussions and evaluation of the strength of scientific methods of studies by the group as well as opportunity to discuss each written draft in total as a group. In the end, all authors contribute writing, reviews, and edits to all sections of the report. The result is truly a group product extending over several months.

BOX 2 TYPES OF SCIENTIFIC EVIDENCE

Scientific studies considered in this report are of following types:

- **Mendelian randomization studies** are those that rely on genetic variants that are related to alcohol consumption in order to indirectly study effects of alcohol consumption.
- **Randomized controlled trials** "flip a coin" to randomly assign one group of participants to an intervention and another to not partaking of that intervention (e.g. experimental lab studies that administer alcohol to participants in the intervention group).
- **Observational studies** generally use data obtained from non-randomly "observing" participant self-reports of alcohol use to investigate whether drinking affects risk of mortality or morbidity from various diseases.
- **Neuroimaging studies** use non-invasive imaging technology (e.g. Magnetic Resonance Imagining [MRI]) to study the structure and function of the brain and central nervous system under certain conditions (e.g. presence or absence of alcohol).

Each type of study brings its own strengths and weaknesses. As discussed in previous reports, non-randomized observational studies are particularly prone to finding spurious protective effects from low-to-moderate alcohol intake for conditions that are more likely to occur in middle and older age.

2 Mechanisms

Binge drinking has long been recognised as a particularly harmful form of alcohol consumption. It is primarily this form of drinking, with its social and behavioural consequences, that has led to the regulation of drinking in most countries in the world. In more recent research, binge drinking is also found to exert a profound impact on human physiology and pathology.

Binge drinking is a pattern of drinking that involves the rapid consumption of large volumes of alcohol. The key difference between binge drinking and regular high consumption is the rate of consumption, where rapid consumption leads to a rapid rise in BAC, which the detoxification enzymes can't cope with.

Alcohol is a small molecule that easily reaches all tissues in the human body and readily crosses the blood brain barrier. When drinking, two types of reactions occur.[3] One is the intoxicating effect, where alcohol binds to several neurotransmitter systems (GABA, NMDA glutamate, dopamine). This effect often is perceived as pleasurable, with relaxation and lowered inhibition, but also generates impaired coordination, slowed reflexes, slurred speech, memory impairment, and, in severe cases, increased sedation and coma. This is entirely an effect of ethanol in itself on the brain. The other reaction, the unpleasant effects, including nausea, headache and organ harm, which are caused by acetaldehyde and oxidative stress.

The elimination of ethanol at lower concentrations increases linearly with rising alcohol concentration. However, this phase is limited because the primary metabolising enzyme, alcohol dehydrogenase (ADH), becomes saturated[4,5] at low BAC levels, roughly the level achieved after drinking one standard drink.

At low levels of drinking, ADH metabolises ethanol to acetaldehyde, which in turn normally is metabolised by aldehyde dehydrogenase (ALDH) to acetate. The key is whether acetaldehyde is efficiently detoxified by ALDH. If ALDH can keep up, blood acetaldehyde remains low. But with rapid drinking, ADH and ALDH both get saturated, resulting in continued and increasing high levels of ethanol and acetaldehyde respectively.

At low ethanol concentrations, acetaldehyde levels remain low but non-zero.

But even at these low levels, acetaldehyde has biological activity, and in some situations can lead to effects. In East Asian populations, up to ~40% carry a genetic variant of ALDH[6] which leads to reduced capacity to convert acetaldehyde to acetate. In these populations even one drink can lead to acetaldehyde spikes with flushing, headache, tachycardia and nausea and will increase cancer risk.

The more common ALDH variant, carried by most Europeans and Africans, results in quicker metabolism of acetaldehyde to acetate. Clinical symptoms of intoxication (disinhibition, slowed reflexes) are due to ethanol itself, not acetaldehyde. Acetaldehyde here likely contributes little, though subtle effects (mild vasodilation, warmth) can occur.

However, even if the systemic effects of low levels of acetaldehyde are negligible, acetaldehyde can accumulate locally in saliva and mucosa after small doses, due to oral bacteria metabolism. This is thought to explain the link between even light drinking and increased oral/oesophageal cancer risk.[7]

Furthermore, metabolism is increasingly shunted to a secondary system, the microsomal ethanol oxidizing system (MEOS), with the enzyme Cytochrome P-450 2E1 (CYP2E1). These metabolic shifts occur at increased consumption, especially in cases of chronic high consumption, when ADH/ALDH become saturated. The common definition of binge drinking is based on the behavioural effects of increasing ethanol. For the more long-term organ damage, based on MEOS and CYP2E1, an increase in harm is seen, with increased consumption.[8] Oxidative stress results from an imbalance between the production of reactive oxygen species (ROS) and the body's capability to cleanse these reactive intermediates. The more and the faster you drink, the more metabolism shifts toward CYP2E1 with escalating ROS and cumulative acetaldehyde exposure.

Acetaldehyde is a toxic intermediate from ethanol metabolism and appears when ALDH is unable to cope with high levels of acetaldehyde, resulting in a further buildup of acetaldehyde levels. Acetaldehyde crosses the blood–brain barrier, but it is normally metabolised rapidly by ALDH, so in most people it doesn't accumulate enough in the brain to drive the feeling of being drunk.

CYP2E1 metabolism produces reactive oxygen species (ROS) and contributes to cellular damage and inflammation.[9] This cellular damage in many organs (e.g., liver, pancreas and brain), leads to long-term harms, such as cirrhosis, pancreatitis, alcohol use disorder, and cancer, but is not a cause of immediate feelings of being drunk. Fast, high BAC peaks are metabolically more severe than moderate increases in BAC. Once ADH is maxed out, additional ethanol increasingly relies on pathways that generate more oxidative stress. Prolonged alcohol exposure enhances ROS generation, ultimately contributing to cellular damage and loss.

Consequences of binge drinking are not short-lived nor limited to the period of intoxication.[10] Imaging studies of binge drinking adolescents document long-lasting changes in the brain. Reports indicate structural changes in the prefrontal and parietal regions, as well as in regions known to mediate reward. These changes are thought to underpin long-lasting

The key difference between binge drinking and regular high consumption is the rate of consumption, where rapid consumption leads to a rapid rise in BAC, which the detoxification enzymes can't cope with.

effects of binge drinking on critical neurodevelopmental processes and, in particular, those involving executive functions. Impaired executive functioning, e.g., problem solving and the ability to exert self-control, are key components in the development of alcohol use disorder. Furthermore, brain research from the past ten years shows that even low or moderate levels of alcohol consumption are associated with brain atrophy, especially of the hippocampus,[11,12] where memories are formed and consolidated.

Binge drinking often occurs apart from meals, which may also contribute to its deleterious effects. Food consumed at the time of alcohol consumption influences not only alcohol absorption rate and blood alcohol concentration, but also the direct effect of alcohol on the gastrointestinal mucosa. Hence, binge drinking is more likely to contribute to organ injury than slower-paced consumption that is associated with a meal.

Some alcohol is metabolised in the brain. Although brain metabolism does not significantly contribute to inter-individual variation in BAC following alcohol ingestion, it is clinically significant due to its acute effects on behaviour and reward.[13]

In summary, some of the consequences of rapid drinking of large volumes of alcohol include:

- Toxic effects of ethanol itself;
- Acetaldehyde accumulation, leading to headache and other hangover symptoms;
- Oxidative stress leading to liver inflammation, fibrosis, cancer and other organ damage;
- Neurochemical dysregulation and increased addiction risk from increase in dopamine and reduced executive functioning;
- Loss of control over drinking and acute intoxication.

3 Drinking patterns and their prevalence

Consumption of large quantities of alcohol during a single occasion, i.e. binge drinking, is a highly prevalent behaviour throughout many countries[14] and carries considerable short-term and long-term risks to health and safety. For most countries, total alcohol consumption and rates of binge drinking in a population are closely related. For many, if not most high-income countries, at least 50% of total alcohol consumption can be attributed to episodic binge drinking occasions.[15] For lower income countries the contribution of binge drinking to total population consumption may be much higher. When under-reporting in surveys is accounted for, estimates of binge drinking's contribution to total alcohol consumption in a population may be even higher.

Approximately 30% of people living in OECD countries reported binge drinking at least once during the past month.[14] Prevalence of binge drinking behaviours can vary considerably between demographic groups (e.g. age, sex, socioeconomic status) and over time. In this context, the term 'prevalence', refers to an estimate of the proportion or percentage (e.g. half, 50%, 5 in 10) of a population said to have a specific characteristic during a specified time period. The term prevalence 'rate' is used interchangeably with population prevalence in this report. At the country level, changes in binge drinking prevalence have variously occurred over time. These changes have been particularly notable among youth, young adults and have pointed to stark differences in binge drinking trends between young females and males.

3.1 Binge drinking and its relationship to a population's total alcohol consumption

As noted, a strong and consistent association has been observed between a population's total alcohol consumption and binge drinking prevalence. This association is readily understandable given the high proportion of alcohol shown to be consumed on binge drinking occasions. In the US, for instance, per capita alcohol consumption and binge drinking are positively correlated at the state level with coefficients of between 0.45 and 0.61.[15] A high-quality study with minimal survey under-reporting found binge drinking occasions accounted for around 50% of all alcohol sales in high-income countries and closer to two-thirds in middle income countries.[16] Using the same instrument and a higher cut-off of 6+/8+ 12 g drinks of alcohol per day, one study[17] found that in many countries, most alcohol is consumed above these levels i.e., on binge drinking occasions. In New Zealand and England this proportion

Binge drinking occasions accounted for around 50% of all alcohol sales in high-income countries and closer to two-thirds in middle income countries.

was around 45%, in Vietnam, Peru, Scotland and Australia the proportion was 50% or just above, in Mongolia and Thailand 62%, and in South Africa 93%. Another study found that when the percentage contribution of binge drinking days to total population consumption was estimated with adjustment for under-reporting in surveys, there was a marked increase, i.e. from 37% of total consumption using unadjusted self-reports to 74% after adjustment.[18]

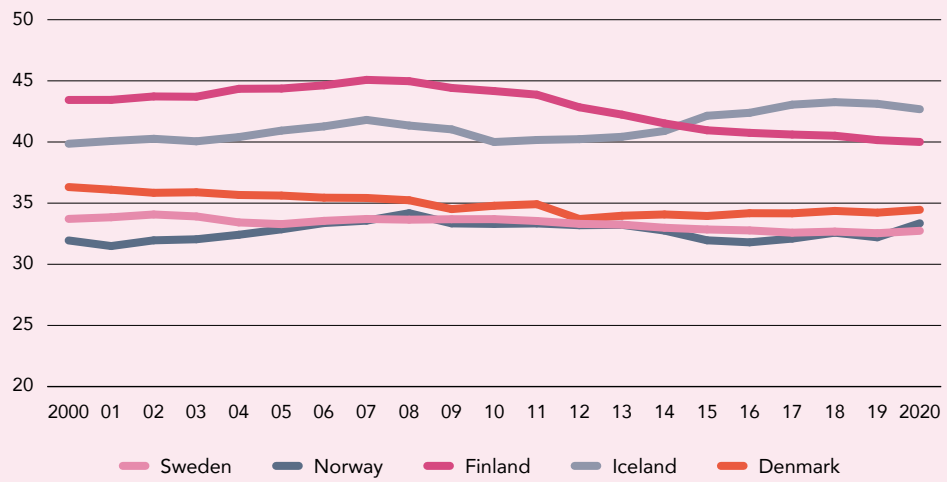
3.2 Binge drinking prevalence

The WHO Global Information System on Alcohol and Health (GISAH) database[19] contains estimates of total alcohol consumption by country. Total consumption includes both recorded use (from country specific records of production, imports, exports, sales data) and unrecorded consumption (i.e. untaxed).

According to a 2021 OECD report which used WHO's GISAH data on total alcohol to model estimates of binge drinking prevalence, about 30% of people living in OECD countries drank more than 60 grams of pure alcohol (equivalent to 5 Swedish standard drinks of 12g pure alcohol) during a single occasion at least once in the past month in 2016. Without exception, national binge drinking levels were markedly higher for males than females and in most countries (and overall), monthly binge drinking was most common among people under 45 years of age.[14]

Figure 1 shows trends in age-adjusted binge drinking prevalence among Nordic countries from 2000 to 2020. These estimates have been derived directly from GISAH data[19] and compiled specifically for this report. In keeping with Swedish reports[20], GISAH data indicated that Sweden experienced only marginal change in levels of binge drinking over time for people aged 15+ and that Swedish rates were on par with the OECD (as were Norwegian and Danish rates in 2020). Binge drinking prevalence in Iceland and Finland were comparatively higher than in Sweden and both showed changes over time, though in opposite directions, i.e., increasing trend for Iceland, decreasing trend for Finland.

FIGURE 1 Trends in estimated age-adjusted prevalence of binge drinking among 15+ year olds in Nordic countries, 2000 to 2020



Source: GISAH, https://www.who.int/data/gho/data/themes/global-information-system-on-alcohol-and-health.
Binge drinking defined as more than 60 grams of pure alcohol during a single occasion at least once in the past month.

Among Nordic countries, binge drinking rates reported by men were about twice that for women. In 2020, age standardised binge drinking rates for men and women aged 15+ years in Sweden were 44.3% and 20.5% respectively compared to 55.3% and 28.6% in Iceland, 52.6% and 26.7% in Finland and 45.2% and 20.7% in Norway.[19]

On average, among those who drink alcohol, people in higher income groups (21%) throughout OECD countries are more likely to binge drink than those in lower income (16%) groups.[21] However, in many countries, prevalence is high for both the lowest and highest income groups. In other words, binge drinking rates are often lowest among the middle socioeconomic groups.[14] For Sweden, corresponding estimates for binge drinking among high- and low-income groups in 2019 were 24% and 15%.[21]

Around 20% of EU residents with higher education report binge drinking at least once a month compared to 13% of people with lower education.[21] Women with higher educational attainment (14%) appear to binge drink at least once a month more often than their less educated (12%) counterparts.[14] It is important to note, however, that studies report substantial variability in peak BAC reached and/or quantity of drinks consumed during a binge drinking episode across socioeconomic groups. A US study found, for instance, that total binge drinks per binge drinker was much higher in low education and income groups compared to groups with high education and income.[22]

Binge drinking among drinkers (as opposed to the total population including non-drinkers) show a marked positive association with deprivation and disadvantage.

Furthermore, adjustment for under-reporting appears to further increase this disparity. One study[23] found that after an adjustment to reduce effects of under-reporting, respondents to a UK survey who were living in the most deprived areas became significantly more likely to binge drink than those in the least deprived areas.

3.3 Binge drinking among adolescents and young adults

During the past decade there has been considerable research interest around apparent changes in uptake of drinking and experience of binge drinking among adolescents and young adults. Declining prevalence of overall alcohol use and binge drinking among adolescents over the past 20 years has been reported for many developed countries.[14]

Although binge drinking (in the last 30 days) remains most prevalent among younger age groups, rates have diminished for those aged under 50 years while simultaneously increasing among the 50+ population.[20]

Across the population, the substantial majority of binge drinking episodes occur among those older than age 25.[24]

According to OECD analyses, proportions of 15-year-olds who experienced drunkenness in 2001–02 compared to 2017–18, decreased from 40% to 23% for boys and from 33% to 20% for girls.[14] In keeping with the overall OECD trend, from the beginning of the 2000s to 2024, fewer Swedish grade 9 students reported binge drinking at least once a month; around 23% for girls and 30% for boys. For 11th grade students, prevalence decreased from around 40% among girls and 50% among boys during 2005 (when surveys started), to 22% in 2024.[25] Interestingly, in Norway, despite declining binge drinking prevalence in mid-adolescence, one study[26] found that by the time cohorts reached their early 20s, no significant differences remained.

Various explanations for apparent declines in youth binge drinking have been canvassed, including: substantial rises in student debt diminishing disposable income; reduced alcohol affordability; social media increasing personal accountability for acts committed under the influence of alcohol; and reduction in time spent socialising in-person.[14,27]

A 2023 Gallup Poll[27] suggested that increasing racial/ethnic diversity and greater proportions of non-drinkers among non-whites in the population is a key reason for declining youth drinking. However, regardless of race/ethnicity the survey also found that young people were now much more likely hold the belief that alcohol, even at moderate levels, is bad for health. Whether this shift in health beliefs translates into actual and sustained behaviour change around alcohol use is not yet clear.

Not all research evidence points to reductions in binge drinking, however. In fact, several countries have reported increases in

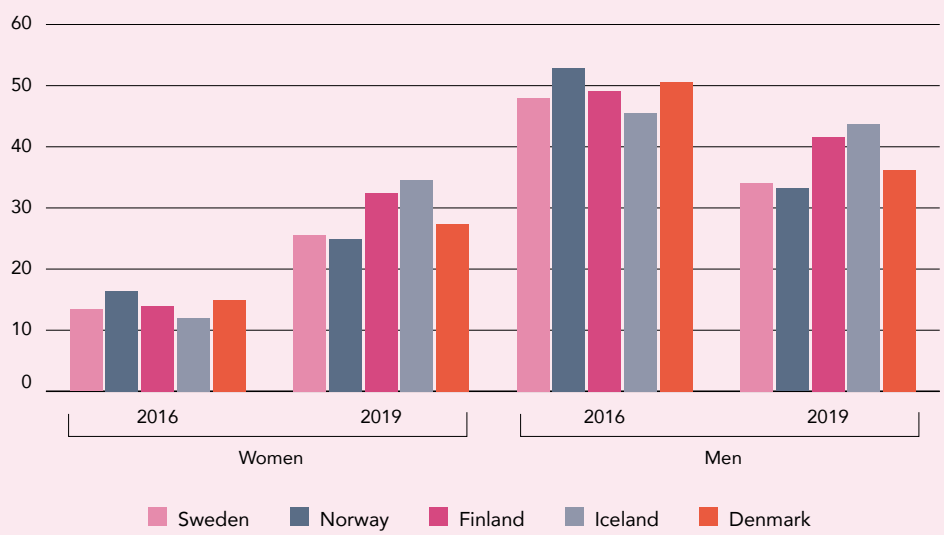
binge drinking indicators specific to young females. This phenomenon appears to point to convergence in binge drinking between the sexes, whereby young females are rapidly 'catching up' with same-aged males.

Using data drawn from WHO's GISAH database, Figure 2 shows binge drinking prevalence estimates for older teenagers aged 15 to 19 years by sex for Nordic countries. All five nations reported higher rates of 15–19 year-old female binge drinking in 2019 compared to 2016. These increases were substantial and occurred over a relatively short time period, ranging from 52% in Norway to 190% in Iceland. In contrast, binge drinking prevalence among 15–19 year-old males fell across the board with declines ranging from 4% (Iceland) to 37% (Norway). Despite the large increases in young female binge drinking rates, male rates were still around 30% higher on average.

It is important to note that due to the fact that young male binge drinking rates were so much higher than for females in 2016 and remained substantially higher than female rates in 2019, overall binge drinking prevalence did not necessarily increase and in fact, either declined or remained relatively stable in three countries (Sweden, Norway, Denmark). In Finland and Iceland, relatively modest declines in 15–19 year-old male binge drinking (15% and 4% respectively) were over-shadowed by very large (130% and 190% respectively) increases among females, resulting in net binge drinking increases of 18% and 36% respectively for those countries. In keeping with these trends, a review of US studies since 2008[28] found that binge drinking among adolescents and young adults has decreased and sex-specific rates have converged due to male binge drinking declining faster.

Several countries have reported increases in binge drinking indicators specific to young females. This phenomenon appears to point to convergence in binge drinking between the sexes, whereby young females are rapidly 'catching up' with same-aged males.

FIGURE 2 Estimated prevalence of binge drinking among 15-19 year-old males and females in Nordic countries, 2016 and 2019



Source: GISAH, https://www.who.int/data/gho/data/themes/global-information-system-on-alcohol-and-health. Binge drinking defined as more than 60 grams of pure alcohol during a single occasion at least once in the past month

4 Risks from Binge Drinking

One's blood alcohol concentration (BAC) is key to determining an individual's risk of alcohol-related harm.

A range of factors affect, or modify, a person's risk of harm from binge drinking. Key factors include level of Blood Alcohol Concentration (BAC) reached during the drinking occasion, young age, sex and gender, lower socioeconomic status, and maternal and paternal alcohol use.

4.1 Blood alcohol concentration

Alcohol is a central nervous system depressant.[29] One's blood alcohol concentration (BAC) is key to determining an individual's risk of alcohol-related harm. As BAC rises, risk of harm increases. This is particularly demonstrable for harms that occur during or within a short time of a drinking occasion (e.g. road crashes, falls). However, there is also increasing evidence for long lasting impacts arising from exposure to high level BACs during binge drinking that increase risk of degenerative disease (e.g. early onset dementia) and mental health problems (e.g. [12,30]).

When alcohol is consumed rapidly, the primary enzyme that normally breaks down the majority of alcohol (alcohol dehydrogenase) becomes overwhelmed. As a result, the body is forced to rely more heavily on alternative metabolism pathways (i.e. the microsomal ethanol oxidizing system) that produce higher levels of both acetaldehyde and organ-damaging free radicals.[31,32] These compounds circulate around the body, potentially damaging cells and organs, and leading to both short-term impairments and long-term damage that can present as degenerative disease many years later. It has been suggested that this biochemical process explains why intermittent binge drinking is more damaging to the human body than regular low-level use at any level of total consumption.[33–35]

Reviews of observational studies have found strong dose–response relationships between amount of alcohol consumed in a drinking occasion and risk of both motor vehicle and non-motor vehicle injury (e.g. [1,36–38]). For instance, odds of a fatal motor vehicle crash increase by 74% for every 0.2‰ (0.02%) increase in BAC. At 0.8‰ (0.08%) BAC – which is the legal driving limit in many countries – risk of a fatal crash is about 13 times higher than at zero BAC.[1,39,40] A comprehensive review of individual-level data showed that the dose-response relationship is non-linear such that risk increases exponentially as BAC increases. For example, compared to no alcohol consumption, drinking 24g of alcohol in a single drinking session approximately doubles the risk of injury, however, at levels of consumption approaching 120g, risk of motor vehicle injury is around 50 times higher.[1]

Even relatively modest elevations in BAC can cause problems. Risk of motor vehicle crash or other unintentional injuries starts to increase at 0.2‰ (0.02%) BAC, or approximately one drink.[38,40] In laboratory

experiments, impairment of reaction time and coordination begins around 0.4‰–0.5‰ (0.04–0.05%) BAC. At this level, people are already at increased risk of accidents and poor decision-making. Laboratory and experimental studies show that even at relatively low levels (e.g. 0.4‰–0.5‰ (0.04–0.05%) BAC), alcohol can impair balance and coordination, visual focus, reaction time, judgment, response inhibition, and change behaviour. A review of over 60 randomized controlled trials (RCTs) of alcohol's effect on neural circuits in the brain using electroencephalogram methods showed that alcohol's negative effects on attention, automatic auditory processing and performance monitoring increased as dose increased and, was detectable at doses as low as 0.26‰ (0.026%) BAC. [41]

When BAC is between 1.0‰ and 2.0‰ (0.10% and 0.20%), serious neurological impairment, including slurred speech, memory problems, and loss of coordination may occur. If BAC is high enough (e.g. >= 3.0‰ (0.30%)), it can result in loss of consciousness, coma, respiratory failure and death.[29,42–45]

However, BAC levels associated with alcohol poisoning deaths are variable, and influenced by factors such as the presence of other respiratory depressant drugs, hypothermia (which frequently accompanies alcohol poisoning, particularly in outdoor environments) and concomitant vomiting, which may cause aspiration and respiratory arrest.

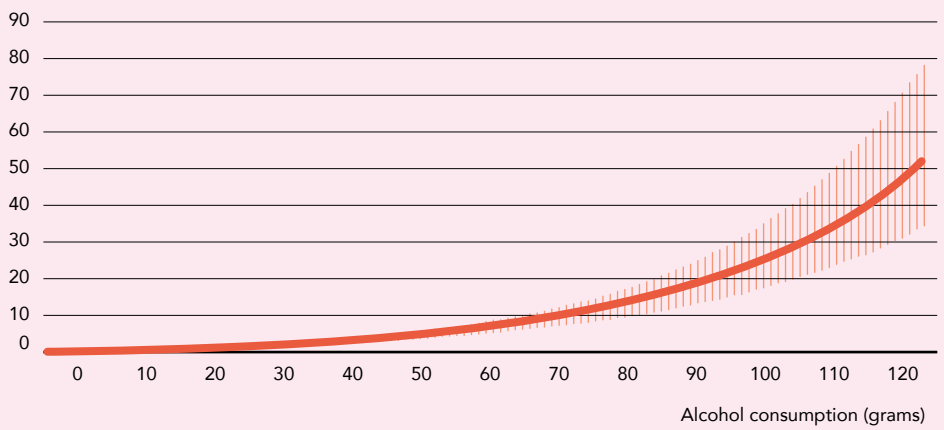
Tolerance to alcohol's effects

Drink-for-drink, alcohol's effects on the human body can vary widely among individuals. Much of this can be explained by individual variations in tolerance to alcohol. Tolerance is related to several metabolic processes.

Firstly, 'metabolic' tolerance arises due to increased efficiency in how the body metabolises alcohol. This results in lower BAC levels for a specific dose of alcohol and the need for higher levels of alcohol in order to achieve the same effects. Many people compensate by drinking more to attain a given BAC level and its desired intoxicating effects.

Secondly, 'functional' tolerance refers to how an individual can learn to perform tasks

FIGURE 3 Dose–response curve for the amount of alcohol consumed 3 h prior and the odds of motor vehicle accident injury



Source: Figure 5 in Taylor et al. (2010). The more you drink, the harder you fall: A systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug and Alcohol Dependence, 110(1–2), 108–116.

under the influence of alcohol at a specific BAC level i.e., with practice, deficits can sometimes be partially overcome. At the extreme end of the drinking spectrum, people with severe alcohol-induced brain and liver damage can experience a dramatic loss of tolerance so that they may exhibit impairment at low doses. Tolerance to alcohol's effects on mood, motor skills and behaviour develops over time with repeated experience of alcohol use, particularly with repeated episodes of binge drinking. Essentially, this means that, over time, someone who drinks frequently may need to consume more alcohol to achieve the same effect.

Drinkers with low tolerance for binge drinking are at risk of death at around 3,0‰ (0.30%) BAC, while individuals with alcohol dependence can sometimes survive at substantially higher BAC levels.[45] This wide variation illustrates how tolerance modifies BAC effect on risk but does not imply that tolerance eliminates risk. Tolerance affects wakefulness and the sensation of intoxication more than other aspects of impairment such as executive functioning.[46] Therefore, those with alcohol tolerance may be more likely to attempt complex tasks (due to feeling more awake and less drunk) while still being considerably impaired. This, paradoxically, can increase the likelihood of engaging in risky behaviour (e.g., driving).[47]

4.2 Age: younger and older drinkers

Age is another key factor that influences risks from binge drinking. Young people are especially vulnerable because their brains and bodies are still developing. Alcohol interferes with normal brain development, disrupting the balance between excitatory and inhibitory neurotransmitters (e.g. glutamate, GABA). Alcohol also retards production of new neurons in the hippocampus (crucial for memory and learning) and causes structural changes in brain areas responsible for decision-making and impulse control. These changes can last long after the drinking episode and when binge drinking begins in adolescence, long-term consequences can be especially damaging.[48–50]

When binge drinking begins early in life, it also brings significant risks of setting in place lifelong risky drinking behaviours. A 15-year prospective study, for example, found that 90% of males and 70% of females who started binge drinking in adolescence continued this pattern into young adulthood.[51]

Generally smaller body mass among young teenagers compared to fully grown adults means that drink-for-drink, young people will attain higher BACs. As described above, individuals who attain higher BACs are at greater risk of injuries and other short-term harms, as well as elevated risk of developing degenerative disease stemming from long-term damage.[12]

For older drinkers, factors affecting risks of harms arising from binge drinking are related to the process of ageing itself. As people age, metabolism slows down, the body contains less water leading to higher BACs from the same amount of drinking. For example, people over 60 years of age who binge drink at least once a month have been reported to have more than a tenfold increased risk of fall-related injuries. Older adults also tend to have lower muscle mass, decreased sensory perception, poorer balance.[12,52,53] Moreover, older people have a higher baseline risk for falls and injuries in general and are more likely to be taking one or more medications which may interact negatively with alcohol use.[54]

4.3 Sex and gender

Both biological sex differences (e.g. hormones, genetics) and gender-based sociocultural constructs (e.g. "masculinity", "femininity") significantly influence risks of harm from binge drinking.

Attributed to both biological (e.g. higher levels of testosterone) and sociocultural determinants, males have, overall, a greater propensity for risk-taking compared to females.[55] Differences in risk-taking propensity are likely to explain why males more often combine binge drinking with activities such as driving and violence than females. This leads to males having higher risks and greater morbidity/mortality from alcohol-related accidents and injuries, even at the same BAC.[56,57]

Drink-for-drink, the typically smaller body size and lower body water of females results in higher BACs compared to males. Studies show that the negative consequences of drinking increase more steeply for women. Between four and nine drinks per occasion, women experience sharp rises in hangovers, vomiting, and blackouts. For men, the increase in harms is more gradual across higher drink counts.[58] A Swiss study of self-reported data on consequences from binge drinking showed that for similar risk levels, consumption for women were about half of that for males.[59] Nonetheless, many national guidelines for reducing risk of harms from episodic drinking apply the same recommendations for males and females, e.g. Swedish clinical guidelines and Australian guidelines.[60,61]

Evidence is also emerging of gender-driven contrasting changes over time in alcohol use and alcohol-related harms for males and females.[28,62–64] In Sweden, binge drinking gender differences appear to have diminished somewhat but they remain more prevalent for men (38%) compared to women (23%).[20] Apparent convergence in alcohol use and harm levels between males and females is particularly stark for young people, among whom binge drinking is most common, with several jurisdictions reporting decreased or stabilized alcohol-related harms among teenage males while female rates have increased.[65] It is possible, however, that at least in part, gender gaps observed in self-report survey studies may be explained by differential under-reporting, e.g.[23].

4.4 Socioeconomic status (SES)

Socioeconomic status is a strong modifier of risks from binge drinking, it plays an important role in shaping how and why people binge drink. People in lower SES groups tend to binge drink less frequently but may

Differences in risk-taking propensity are likely to explain why males more often combine binge drinking with activities such as driving and violence than females.

drink larger amounts on each occasion which leads to higher peak BACs. For example, U.S. data show that total binge drinks per binge drinker are substantially higher among lower compared to higher SES groups.[21,66,67] Importantly, higher BACs result in more serious and frequent harms in the short-term, such as road traffic accidents, violent incidents and poisonings as well as more severe, long-lasting outcomes for the drinker and third parties.[22,68]

In addition to differences in consumption, at any particular level of consumption, lower SES groups are more vulnerable to harms compared to those who are more socially advantaged. This is referred to as the "harms paradox" which is driven by disadvantages in social, economic and underlying health factors, all of which can amplify alcohol-related risk.[67,69] For example, after adjusting for differences in alcohol consumption, rates of alcohol-attributable deaths differed four-fold among racial-ethnic groups in the U.S.[70]

In addition to differences in consumption, at any particular level of consumption, lower SES groups are more vulnerable to harms compared to those who are more socially advantaged.

Binge drinking in vulnerable populations rarely occurs in isolation. It often clusters with other individual risk factors such as (but not limited to) smoking, obesity, poor diet, lack of physical activity, as well as other social factors such as limited access to quality health care services, housing, education and employment opportunities. Together, these intersecting factors multiply health risks from binge drinking and may have particularly negative impacts on degenerative health concerns that typically appear in mid-life, e.g. lower quality of life, poorer outlook, greater risk of premature death.[71]

4.5 Maternal and paternal drinking

Binge drinking during pregnancy, especially when frequent, increases the likelihood that the foetus will be exposed to high BAC levels at critical developmental stages. High-dose exposures may lead to foetal alcohol spectrum disorders (FAS/FASD), which include a range of permanent physical, cognitive, and behavioural problems and other serious outcomes (e.g. spontaneous abortion, premature and still birth).[72–74]

Pregnancy is often not recognized until around five weeks gestation; this is driven in part by the high proportion of pregnancies that are miss-timed, unwanted or otherwise unexpected. Binge drinking among women of childbearing age can increase the likelihood of the fetus being exposed to high blood alcohol levels on one or more occasions. If the mother is unaware of the pregnancy and binge drinking continues during a critical stage of foetal development, risks of lifelong consequences to the foetus are significant. Binge drinking is also associated with unintended pregnancies and delays in recognizing pregnancy, both of which increase the likelihood of harmful foetal alcohol exposure.[72] As such, reductions in binge drinking among women of childbearing age should be a focus of prevention, not just a focus on binge drinking among those who are known to be pregnant.

Paternal drinking also contributes to risk, though in different ways. There is emerging scientific evidence for biological impacts of paternal alcohol use (even at low levels) on the foetus. Although not necessarily attributed to binge drinking per se, biological effects of paternal alcohol exposure prior to conception include reduced sperm health, spontaneous abortion, still birth, as well as foetal heart conditions and some cancers.[75–81]

Paternal binge drinking prior to and during pregnancy is also strongly linked to intimate partner violence, family conflict and household stress. These harms affect both mothers and infants by creating unsafe environments and increasing the likelihood of indirect alcohol-related harm.[72,82] Paternal drinking can also have a profound effect on whether women continue to drink during pregnancy; women who have a live-in male partner who drinks are more likely to continue drinking themselves, especially if the male partner is a heavy or risky drinker.[83]

5 Acute harms

Binge drinking can substantially increase the risk of a variety of immediate ("acute") harms including injuries caused by violence, road crashes, drownings, burns, freezing, and injuries at the workplace. These harms will often be experienced by people other than the drinker e.g. victims of violence, child abuse or road crashes. A heavy drinking episode or binge can result in impaired judgment and ability to perform complex tasks (e.g. operating machinery, driving) and lower risk perception, (see e.g.[84]),

A more recent review of 100 published studies and publicly available data sets with BAC data for North American populations[85] estimated that alcohol was responsible for; 3% of injuries from plane crashes, 9% from child abuse, 31% of drownings, 37% from falls, 34% from burns, 24% from gunshots, 29% of homicides, 29% from hypothermia, 42% from road crashes, 21% from suicide and 27% from boating. It was further estimated that fully 27% of fatal and non-fatal injuries would not have occurred without alcohol use. These are findings echo those by earlier studies.[1,86]

5.1 Road crash injuries

Alcohol-impaired driving is a threat to others as well as to the driver, with evidence that even a low dose of alcohol (e.g. one drink) can significantly impair reaction time and ability to perform complex cognitive tasks frequently required when driving.[87] Degree of impairment increases and even accelerates with rising BAC as has been shown in a systematic review of simulated driving experiments[88] as well as in other reviews.[40,89]

These risks are of course more likely for binge drinkers than regular low level

Findings across a number of international research studies support a conclusion that alcohol's impairment effects exacerbate the likelihood of intentional injuries or violence due to alcohol's role in aggression and impaired decision-making.

drinkers, as demonstrated in a review of international data.[57] In Sweden, for example, men and women arrested for impaired driving had typically drunk more than five drinks. The odds of impaired driving are five times greater for binge drinkers than for other drinkers. One review of acute alcohol consumption and simulated driving[90] found that lane position and speed were significantly worse after alcohol consumption and that performance declined as higher BAC levels were reached. A Spanish study of over 12,000 survey respondents[91] found frequency of traffic crashes increased substantially for binge drinkers.

5.2 Unintentional injuries

Unintentional injuries associated with binge drinking typically include falls, burns, drownings, and workplace injuries arising due to impaired balance, vision, and risk perception. A recent Norwegian study[92] concluded that injury risk increased exponentially with rising BAC i.e. risk level accelerated with higher amounts consumed. Scandinavian studies from Sweden and Norway concur with international reviews[12,93] that heavier alcohol use in older age increases fall risk. In the Norwegian study, risk of fall injuries among those aged 60 years and older was over ten times greater for those who drank to intoxication at least once each month.[92] A review of epidemiological studies[94] found about half of all adult burn patients were intoxicated when admitted and, further, the presence of alcohol increased the risk of a fatal outcome and complications in the recovery of survivors.

5.3 Intentional injuries from aggression, assault, and homicide

Intentional injuries are those resulting from violence, assault, self-harm, suicide or aggression by another. The relationship between BAC and injury risk varies such that intentional injuries have a stronger association with alcohol use than do unintentional injuries. Findings across a number of international research studies support a conclusion that alcohol's impairment effects exacerbate the likelihood of intentional injuries or violence due to alcohol's role in aggression and impaired decision-making. A study of 19 European countries[95] on experiences of aggression (verbally abused, harmed physically, or having serious arguments) found that the risk of experiencing harm from others' alcohol-related aggression increased significantly with increasing population-wide prevalence of binge drinking. Survey studies find sizeable proportions reporting harm from others drinking. Examples are studies from Australia[68,96], from 9 countries[97] (Australia, India, Ireland, Lao People's Democratic Republic, Nigeria, Sri Lanka, Thailand, the United States, and Vietnam), Norway[98], and from Denmark, Finland, Iceland, Norway, Sweden, and Scotland.[99]

Homicide

Binge drinking can be a contributing cause to a violent death (homicide) through impairment of the perpetrator or the victim or both. Over 50% of offenders are intoxicated at the time of the homicide with alcohol being the most cited substance and the level of alcohol utilized is comparable for victims and perpetrators.[100] On average across studies 40–50% of homicide victims tested positive for alcohol, 30–35% met a BAC in excess of 0,8‰ (0.08%).[100,101]

5.4 Sexual aggression and binge drinking

Sexual aggression usually from males toward females is enhanced and increased by alcohol, especially binge drinking. One systematic review[57] also concluded that binge drinking among male college students made them more likely to engage in sexual aggression. The study also found that apart from incapacitation and rape, women who binge drink are also at greater general risk of sexual victimization for many possible reasons: men's misinterpretation of women's drinking as a sign of sexual availability, miscommunication of women's refusals, and women's underes-

timation of hazards from male companions. A longitudinal study[102] also found that adolescents who engaged in frequent binge drinking were more likely to perpetrate sexual harassment and stalking, and more likely to be victims of stalking and dating violence. At time points when adolescents had engaged in binge drinking in the past month, they were also more likely to perpetrate dating violence and more likely to be sexual harassment victims.

5.5 Harm to children

Children and youth can be harmed by the drinking of their caregivers. A Swedish National Public Health Institute survey found that while two thirds of respondents felt it was acceptable to get drunk at home when children were not present, less than 10% considered this acceptable when children were present.[103] A meta-analysis of 12 longitudinal studies from six high-income countries[104] found that caregiver alcohol-related diagnoses were associated with more than twice the rate of child maltreatment. One review of 19 articles[105] found that men's heavy drinking was associated with direct and indirect harms for children, including family conflict, maltreatment, and emotional distress.

A study of eight countries[106] (Australia, Chile, Ireland, Lao People's Democratic Republic, Nigeria, Sri Lanka, Thailand, and Vietnam) found harms to children were highly associated with drinking behaviour of their caregivers. Studies which have specifically examined effects of binge drinking on children suggest that: there is a negative effect from fathers binge drinking[107]; a doubling of odds of not completing high school with weekly or more binge drinking by fathers[108] and, that binge drinking by fathers was significantly associated with risk for substance-related disorders in (Swedish) children.[109] A Norwegian study of parental binge drinking found weekly or more frequent binge drinking in fathers negatively affected high school graduation prospects in their offspring.[108]

5.6 Alcohol poisoning

The mechanism for alcohol poisoning involves a combination of paralysis of respiratory and circulatory centers in the brain, potentially leading to a state of asphyxiation, i.e. the body is deprived of oxygen and vital organs begin to fail. Binge drinking can achieve a high BAC in the drinker in relatively short time. A binge drinker will experience alcohol poisoning at BACs of 3.5‰ (0.35%) or higher but even a BAC of 2.5‰ (0.25%) can put the drinker at risk of coma. Children and less experienced drinkers can be at risk at much lower BACs.

Alcohol poisoning mortality and alcohol-related psychosis hospital admissions can occur at BACs from 1‰ to 12‰ (0.1% to 1.2%). While the percentage of hospital patients admitted specifically for alcohol poisoning can be small, the broader impact of alcohol on hospital admissions is substantial.[110–112]

6 Chronic harms

6.1 All-cause mortality

Most deaths in developed countries are caused by chronic diseases. A US study[113] with survey data from 1997 to 2014 found that binge drinking one or more days a week was associated with a higher risk of mortality from all causes compared to life-time abstainers (1.15; 1.09 to 1.22). There was also an increased risk for cancer (1.22; 1.10 to 1.35), and accidents (unintentional injuries) (1.39; 1.11 to 1.74)).

Between ages 40 and 75, never-drinkers and moderate drinkers who did not binge drink had the longest disease-free life span (about 29–30 years). The shortest disease-free life span was seen in people with alcohol poisoning (about 23–24 years) and in heavy drinkers who binge drank (about 26–28 years). Overall, never-drinkers and moderate non-binge drinkers lived 5–6 more disease-free years than those with alcohol poisoning, and 2–3 more years than heavy binge drinkers.[114]

6.2 Cardiovascular disease (CVD) and stroke

Binge drinking is strongly implicated in cardiovascular morbidity and mortality. It increases the risk of hypertension, ischemic heart disease, atrial fibrillation, cardiomyopathy, and sudden cardiac death, elevates both ischemic and haemorrhagic stroke risk and increases coronary artery calcification (by 100% or 2 times with binge drinking).[115–117]

While some earlier work suggested that low-to-moderate drinking could have a protective effect, more recent reviews conclude that binge drinking patterns negate any cardioprotective benefit, instead driving a monotonic increase in CVD risk.[118–121]

Overall, binge drinkers have higher blood pressure and are more likely to develop hypertension compared to non-binge drinkers who consume alcohol weekly or more often but at low to moderate levels. Binge drinking in adolescence, young adulthood and middle age increases the risk of developing **high blood pressure** years later and during older age.[121]

For **ischemic heart disease** (IHD), many large reviews and meta-analyses show an increased risk for fatal ischemic heart disease (i.e., coronary heart disease). Most studies find a 1.5–2.0 × higher risk (50–100% increase). Some high-risk groups (e.g., Finnish Kuopio cohort, Russian men, or post-MI patients) show 2–3 times higher risk. Meta-analyses find around a 1.6–1.8 times increased risk for fatal IHD events associated with binge drinking. This means that binge drinkers have at least 60–100% higher risk of fatal IHD events, with some populations seeing up to 200–300% higher risk.[122–129]

Risk for **atrial fibrillation** is between 30% and 50% higher among populations that binge drink compared to populations with non-binge patterns. For regular heavy drinkers (e.g. at risk of alcohol use disorder), episodic binge drinking can double the risk of atrial fibrillation (i.e., a100% increase). Evidence for this effect is consistent across large cohorts, case-control studies, and experimental physiology.[116]

For **stroke**, a number of reviews and meta-analyses confirm that binge drinking significantly increases risks of both ischemic (blood clot) and haemorrhagic (bleeding) stroke.[130–136] For ischemic stroke, binge drinking increases risk by 1.2–1.6 times. Risk for haemorrhagic stroke is consistently higher, typically 1.5–2.5 times. Binge drinking doubles (or more) the risk of having a stroke in the immediate future i.e., within 24 hours. The main mechanism is through acute increases in blood pressure, but other factors such as inflammation and impact on the arterial walls such as endothelial dysfunction are likely contributors.

6.3 Dementia and cognitive impairment

There is strong evidence that binge drinking contributes to the development of dementia, particularly early-onset dementia. The likely mechanisms for this, such as direct toxic effects of ethanol and acetaldehyde, as well as increased inflammation through ROS and other inflammatory metabolites, are described earlier.

A large Swedish cohort of nearly 500,000 men found that adolescent binge drinking was the strongest predictor of early-onset dementia, while episodes of alcohol-induced unconsciousness more than doubled the risk of both early- and late-onset dementia, including Alzheimer's disease and vascular dementia.[137] Twin studies also demonstrate that binge drinking independently predicts cognitive decline and impairment, even after adjusting for total alcohol consumption, highlighting the role of drinking patterns over cumulative volume.[138,139] These findings are reinforced by meta-analyses and longitudinal cohorts showing that heavy or binge alcohol use increases long-term dementia risk, including Alzheimer's and vascular dementia. [11,140–142] Binge or heavy drinking is associated with 50–100% higher long-term dementia risk, with some studies showing more than two times greater risk for early-onset or vascular dementia.[143]

6.4 Mental health

Binge drinking is associated with a range of psychiatric outcomes, including depression, anxiety, and suicide. Overall, binge drinking increases depression risk by 50–80% and at least doubles suicide attempt risk.

Risks are particularly pronounced in socially disadvantaged groups.[144] Mendelian

Many large reviews and meta-analyses show an increased risk for fatal ischemic heart disease (i.e., coronary heart disease). Most studies find a 1.5–2.0 × higher risk (50–100% increase).

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randomization studies suggest a bidirectional link, where binge drinking both contributes to and results from poor mental health.[66] In addition, binge drinking frequently co-occurs with other risk behaviours such as violence, self-harm, and risky sexual activity, which compound its psychiatric burden.[57] These findings are supported by systematic reviews and meta-analyses showing that binge drinking is independently associated with higher risk of major depression, anxiety disorders, and suicidal ideation.[145–149] Large-scale Mendelian randomization studies further highlight shared vulnerabilities linking binge drinking and psychiatric illness.[66]

These associations are reinforced by recent systematic reviews and meta-analyses showing that binge drinking significantly elevates risks of depression, anxiety, and suicidal behaviour.[144,150–154] Evidence indicates both acute and longer-term increases in risk, particularly in adolescents and socially disadvantaged groups.

6.5 Cancers

Alcohol is classified as a Group 1 carcinogen, is associated with 10 different types of cancer, of which 7 are causally related to alcohol consumption according to the International Agency for Research on Cancer or the World Health Organization. These cancers include breast cancer, colorectal cancer, liver cancer, oral cancer, pharyngeal cancer, laryngeal cancer and squamous cell cancer of the oesophagus. Both ethanol, acetaldehyde and inflammatory ROS species contribute to cancer development, by causing DNA damage and inflammation (see chapter 2. Mechanisms).

In addition to the contribution of binge drinking to the total consumption of alcohol, binge drinking may increase cancer risk, but this is an area with a relative lack of research. The most robust evidence is for female breast cancer, where both the number of drinks per occasion and the frequency of binge drinking increase risk, independent of average consumption.[155] A systematic review found that women who binge drank had a higher risk of breast cancer.[156] Large cohort studies support this: the Danish Nurse Cohort and the U.S. Nurses' Health Study both showed that weekend or monthly binge drinking increased breast cancer risk, even after adjusting for overall alcohol intake.[57] Case-control studies have also shown increased risk in Māori women (55% increase) and U.S. women with higher weekly ethanol intake.[57] More recent studies report similar findings: one study published 2020 found a 1.8-fold increase overall and a twofold increase for premenopausal breast cancer, while another study from 2017 showed that ever binge drinking raised risk by 30–40%.[157,158] A U.S. study further linked binge drinking to early-onset breast cancer.[159]

Binge drinking has been associated with higher mortality from all cancers in U.S. surveys.[113,160] Site-specific risks include head and neck cancer, where drinking frequency (but not daily amount) predicted risk[161–163], and lung cancer in Finland, where binge drinkers had nearly double the risk, particularly among smokers.[164] For men, the Finnish Twin Study found that binge drinking increased prostate cancer risk by 30%, while heavy drinkers had an even greater risk.[165]

6.6 Diabetes

Epidemiological studies of alcohol and diabetes show that binge drinking increases risk for type 2 diabetes (T2D) regardless of the level of average consumption.[166–168] Overall, large scale studies and meta-analyses show an increased risk for type 2 diabetes by 30–80% with binge drinking or heavy drinking. They also show worsened glycaemic control and increased risk for complications in people with diabetes. These findings suggest that episodic heavy drinking contributes to insulin resistance and long-term metabolic dysregulation.[169–173]

The Northern Swedish Cohort found that binge drinking during adolescence and midlife was associated with higher fasting glucose in women.[174] A large Mendelian

randomization study based on Danish and British cohorts investigated cardiovascular risk and found an increased risk for diabetes as a secondary outcome, especially for heavy alcohol consumption (based on high average consumption), but did not specifically examine binge drinking.[175]

Another Mendelian randomization study using a Korean cohort found higher alcohol intake in men particularly was associated with increased risk for type 2 diabetes, and that no protective effects were found at any level of consumption.[176] However, this study did not assess effects of binge drinking in particular, only regular heavy drinking.

6.7 Gastrointestinal disease, including liver disease

Binge drinking is a major contributor to development of alcohol-related liver disease (ALD), including fatty liver, alcoholic hepatitis, and cirrhosis. It also accelerates the progression of underlying liver disease, especially in those with Metabolic dysfunction-Associated Fatty Liver Disease (MAFLD).[177,178] MAFLD is now a leading cause of liver disease associated with metabolic factors that contribute to diabetes, overweight and high blood pressure. While higher total consumption is the key driver of ALD, binge drinking adds incremental risk through oxidative stress, immune dysregulation, and inflammatory mechanisms.[179,180] A global meta-analysis confirms that ALD accounts for a substantial share of chronic liver disease burden worldwide, with binge drinking accelerating its onset and severity.[181]

Binge drinking is also a major risk factor for inflammation in the pancreas. A series of meta-analyses show that binge drinking significantly raises risk for both acute (by 2.5 times) and chronic (by 2 times) pancre-

Systematic reviews confirm that even few binge episodes during early pregnancy can cause harm, particularly as many women binge drink before recognizing pregnancy.

atitis.[182–184] Moreover, binge drinking often coexists with chronic liver disease, further aggravating health outcomes.[185]

Binge drinking is also strongly related to peptic ulcer disease (PUD), and interacts with other PUD risk factors such as cigarette smoking and the use of non-steroidal anti-inflammatory medications such as ibuprofen. Drinking can also cause exacerbations of existing PUD including perforation or bleeding, and can exacerbate pancreatitis in the form of haemorrhage, pseudocyst or the development of chronic pancreatitis.[179,186,187] A review also notes that even a single episode of heavy drinking can cause duodenal erosions, jejunal mucosal injury, and gastrointestinal bleeding.[188]

One plausible mechanism for chronic disease development is that alcohol disrupts the gut microbiota, contributing to increased intestinal permeability and systemic inflammation.[189,190] Recent Mendelian randomization evidence links alcohol consumption causally to multiple GI diseases, including pancreatitis, reflux disease, and liver disorder.[190]

6.8 Foetal alcohol syndrome (FAS) and Foetal alcohol spectrum disorders (FASD)

Prenatal alcohol exposure, and especially binge drinking, is the direct cause of FAS and FASD, which are defined by neurodevelopmental delay, cognitive impairment, and behavioural disorders in the child. Systematic reviews confirm that even few binge episodes during early pregnancy can cause harm, particularly as many women binge drink before recognizing pregnancy.[73,191] The teratogenic risk is amplified by the high peak blood alcohol concentrations achieved during binge episodes, but no level of alcohol exposure is safe.

Around 10% of women use alcohol during pregnancy, and global prevalence estimates show that one in 13 women who drink during pregnancy gives birth to a child with some degree of foetal alcohol disorder, with binge drinking patterns driving the highest risks. One of every 23 heavy-drinking pregnant women will deliver a child with FAS, which is the most severe of the diagnoses under the FASD-umbrella.[192,193]

A Nature Reviews synthesis underscores that alcohol is the only cause of and a modifiable risk factor for FASD, with risk amplified when exposure occurs before pregnancy recognition and with increasing BAC.[194] A hierarchical meta-analysis of six prospective US cohorts showed that moderate-to-heavy prenatal alcohol exposure – including binge drinking – was consistently linked to cognitive and behavioural impairment in offspring, strengthening causal evidence.[195] A systematic review and meta-analysis of child neuropsychological outcomes found that binge drinking during pregnancy was associated with poorer executive function, attention, and memory.[196] Cohort evidence from Denmark and other Nordic countries confirms that heavy episodic drinking in pregnancy is associated with low birthweight, prematurity, and dysmorphic features, beyond total alcohol intake.[197,198]

It is important to note that there is no level below which alcohol use is risk-free, as even occasional drinking can be associated with congenital anomalies[75], adverse birthweight outcomes[199], and later mental health issues.[200] Mechanistic studies suggest effects on DNA methylation and immune system development.[201–205]

In conclusion, all prenatal alcohol exposure is a risk and no safe lower limit can be defined, but binge drinking, with its high blood alcohol peaks, produces the most harmful effects on foetal development.

7 Strategies/interventions for reducing harms from binge drinking

Binge drinking is the fundamental building block of most alcohol-caused medical, social and economic problems. Fortunately, there are a number of effective public policies that can reduce binge drinking and resulting harm in the general population. In addition to public policies, individually based interventions can also be effective and are an important complement to broader public health strategies.

Most people who engage in binge drinking, and the vast majority of binge drinking episodes, accrue to those whose average consumption might be considered 'moderate' from a social or research perspective. However, binge drinking is also a strong risk factor for subsequent alcohol use disorder, AUD. AUD is a medical condition in which treatment and individual intervention are essential. Thus, strategies to reduce binge drinking can operate at both the population level through public policy and at the individual level as an important complement to broader public strategies.

7.1 Public policies

Binge drinking is a risk behaviour which can be reduced through population-based prevention strategies. A number of effective public policies exist which can reduce binge drinking and resulting harms in the general population.[206]

Although not all policy studies evaluate impacts on binge drinking, international alcohol research has long demonstrated that changes in consumption are highly associated with changes in binge drinking.[207] That is, total alcohol use correlates with changes in other measures of consumption, including binge drinking.[15] For example, if a policy intervention reduces total consumption in the population then that policy intervention also reduces binge drinking. This makes sense since 5+ drinking occasions account for a majority of alcohol consumption in the population.[16,18] Thus, reductions in total or average daily alcohol consumption means that binge drinking is also lower.

Policies resulting in reductions in outcomes related to acute alcohol impairment (e.g., alcohol-involved traffic crashes, violence, unintentional injuries) also offer strong indirect evidence that those policies must be reducing high per-occasion consumption, including binge drinking. Thus reductions in drink driving crashes among under 21 age drivers means high volume per occasion drinking has been reduced.

Some alcohol policies target binge drinking specifically, either directly or indirectly. Examples of laws that directly target binge drinking include those that forbid serving alcohol to intoxicated patrons or minors and laws forbidding public intoxication. Policies indirectly targeting binge drinking include earlier closing hours for bars or liquor stores because of the recognition that large proportions of those drinking very late at night or early in the morning are already impaired. Minimum alcohol purchase age laws are effective in part because of their effects on binge drinking, i.e., the prevalence of binge drinking is high among underage youth as are incidences of impaired driving. A greater proportion of alcohol consumption among youth is accounted for by 5+ drinking occasions.[208] Minimum unit pricing is effective in part because the cheapest alcohol products are disproportionately consumed by those who drink the most on a per-occasion basis. In addition, liability laws hold alcohol retailers liable for damages incurred because of service to intoxicated patrons, and social host laws hold adults criminally liable for intoxication-related harms incurred or caused by underage youth to whom they served alcohol. Finally, most laws and policies to reduce drink driving are inherently designed to reduce the likelihood of driving among those who are impaired by alcohol (e.g., BAC limits for driving, late night driving restrictions for youth, sobriety checkpoints).

The most cost-effective alcohol policies affect alcohol's affordability (i.e., price), its physical availability, or its social acceptability. The most common pricing policy is alcohol taxation, which can be levied as excise taxes (a monetary amount per volume of alcoholic beverage) or ad valorem taxes (based on a percentage of price). In addition to the impact of tax on population-level consumption and harms, there is a large literature demonstrating that higher prices from tax increases reduces binge drinking[209,210] and harmful outcomes related to high per-occasion consumption[211] (e.g., impaired driving, violence). Minimum unit pricing imposes a floor price based on ethanol content. Research evidence indicates that raising minimum unit prices reduces overall consumption, reduces consumption in heavy drinking households, reduces cirrhosis mortality, and reduces mortality risks among those with an AUD (virtually all of whom binge drink).[212] In terms of consumption at bars and restaurants, discounted drink specials may be associated with binge drinking, driving under the influence, fighting, and unprotected sex.[213]

Examples of effective policies that restrict the physical availability in addition to minimum age of alcohol purchase include restrictions on hours or days of alcohol sales,[214,215] bans on sales, and limits on the number of alcohol outlets (either outlets where alcohol is consumed 'off-premises' such as liquor stores or supermarkets, or outlets where alcohol is consumed 'on premises' such as bars, restaurants or nightclubs). Especially helpful

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Government monopolies on alcohol sales, either at the wholesale or retail levels, tend to be associated with fewer alcohol-caused harms and may operate through several mechanisms including price, availability, and more responsible marketing practices.

are studies which have specifically evaluated their potential to reduce binge drinking or related outcomes such as violence,[216] including intimate partner violence.[217] Such studies are direct demonstrations of the potential of public policies to actually have population effects.

Policies pertaining to social acceptability include restrictions (or lack thereof) on alcohol marketing; more marketing is associated with increased binge drinking.[218] While studies have shown that exposure to alcohol marketing is a risk factor for youth drinking and youth binge drinking,[219] these are not intervention studies to assess the impact of restrictions in marketing (there have been few examples in this direction). Efforts to de-glamorize alcohol consumption through counter-marketing or informational messaging have not been well studied. Social acceptability also covers the issue of health warnings on alcohol labels, which may decrease consumption,[220] as well as increase support for labelling and other alcohol control measures.[221]

Government monopolies on alcohol sales, either at the wholesale or retail levels, tend to be associated with fewer alcohol-caused harms and may operate through several mechanisms including price, availability, and more responsible marketing practices. Increases in privatization are associated with increased excessive drinking (including binge drinking) and related harms.[222,223]

A number of studies have examined the impact of the aggregate alcohol policy environment or multiple policies on binge drinking or outcomes related to impairment. For example, a 10% increase in a scale measuring the restrictiveness of U.S. state alcohol policies was associated with a 9% decrease in binge drinking prevalence among adults224 and an 7% decrease in prevalence among underage youth.[225] Alcohol taxes and outlet density accounted for approximately half of the effect magnitude observed for all 29 policies.[226] The same policy scale found that stronger policy environments were protective against harms to others, particularly related to vandalism and impaired driving.[227] A study across 28 countries using the International Alcohol Policy and Injury Index concluded that more restrictive alcohol policies are associated with lower the rates of alcohol-related injury.[228]

Suicide is a complex phenomenon, but many suicides involve impairment level BACs which can trigger suicide through acute dysphoria and impulsivity. A review found that a number of policies are associated with a reduced risk of suicide.[229,230]

7.2 Treatment and individual level interventions

Population strategies reduce binge drinking for the total population including persons with alcohol use disorder because virtually all persons with AUD engage in binge drinking, often on a regular basis. There are also individually based interventions that can reduce binge drinking or the consequences of binge drinking. Those with AUD should be referred for treatment which may involve counselling, medications or both. The success of these treatments relies to a large extent on the severity of alcohol dependence. Although there is no specific treatment for binge drinking, binge drinking is related to loss of control, which is a core symptom in alcohol dependence.

Medications including naltrexone, acamprosate and baclofen reduce binge drinking episodes.[231] Disulfiram remains the most effective medication to reduce drinking, including binge drinking. Behavioral interventions including behavioral self-control training also reduce binge drinking frequency and severity. GLP-1 agonists, used mainly for diabetes and weight loss, are an exciting new class of medications with promising evidence of effectiveness for AUD.[232] Psychedelics are another promising therapeutic option which may reduce binge drinking days,[233–235] but more studies with less risk of bias are needed.

Brief counselling interventions, which are typically 5–15 minutes sessions that use motivational interviewing or structured advice, are for patients who are screened for risky drinking (including binge drinking) regardless of their meeting the criteria for AUD. Such interventions have the potential to reduce consumption and binge drinking.[236] The focus in these interventions is on the harmful effect of alcohol on the presenting disorder, rather than on a diagnosis of AUD.

Other individually-oriented interventions include ignition interlock devices to reduce impaired driving among those convicted of impaired driving,[237,238] and newer driver alcohol detection system for safety (DADSS) which is a passive sensor to detect elevated BACs in the driver which can block the car's ignition system that is being developed by the National Highway Traffic Safety Administration (NHTSA) and the Automotive Coalition for Traffic Safety in the U.S. DADSS technology could be mandatory equipment in all motor vehicles, similar to seatbelts or airbags.

8 Conclusions and recommendations

Binge drinking is a major contributor to serious alcohol-related harm that has been largely overlooked and underestimated. Binge drinking is a dangerous pattern of consumption that involves consuming a large quantity of alcohol in a short period, typically leading to blood alcohol levels high enough to cause significant impairment. While definitions vary, consuming 4–5 or more drinks in one occasion or sitting is generally considered binge drinking. This pattern of drinking is dangerous because it leads to sudden spikes in blood alcohol concentration, overwhelming the body's ability to process alcohol, leading to oxidative stress and to an increase in acetaldehyde, a dangerous metabolite and a major carcinogen.

8.1 Why it matters

Binge drinking is common worldwide. In most high-income countries, over half of all alcohol consumed happens during binge drinking occasions, but in many low- and middle-income countries it is even more common. Binge drinking can cause greater harm in disadvantaged groups or groups with structural vulnerabilities. Binge drinking is also responsive to an array of population-based preventive strategies, discussed above.

8.2 Health risks

Binge drinking carries both immediate ("acute") and or long-term ("chronic") risks to health. That binge drinking often results in immediate consequences for health may be readily apparent to many drinkers and the harms themselves often highly visible from a societal perspective. In contrast, longer-term harms to health from binge drinking are more easily overlooked or under-estimated by drinkers and society at large, even though for some, binge drinking impacts may endure throughout life. For example:

- **IMMEDIATE HARMS;** Accidents, falls, car crashes, violence, sexual assault, alcohol poisoning, and harm to children from impaired caregivers.
- **LONG-TERM HARMS;** Alcohol use disorder (i.e., alcohol dependence), heart disease, stroke, dementia (especially early onset), depression, cancers (especially breast, liver, and mouth cancers), liver disease, pancreatitis, diabetes, and gastrointestinal damage.
- **ENDURING IMPACTS;** For young people, binge drinking can disrupt brain development and increase the likelihood of developing an alcohol use disorder, chronic diseases or dementia later in life. Drinking during pregnancy can cause serious lifelong conditions such as foetal alcohol spectrum disorders (FASD).

In most high-income countries, over half of all alcohol consumed happens during binge drinking occasions, but in many low- and middle-income countries it is even more common.

8.3 Social and economic costs

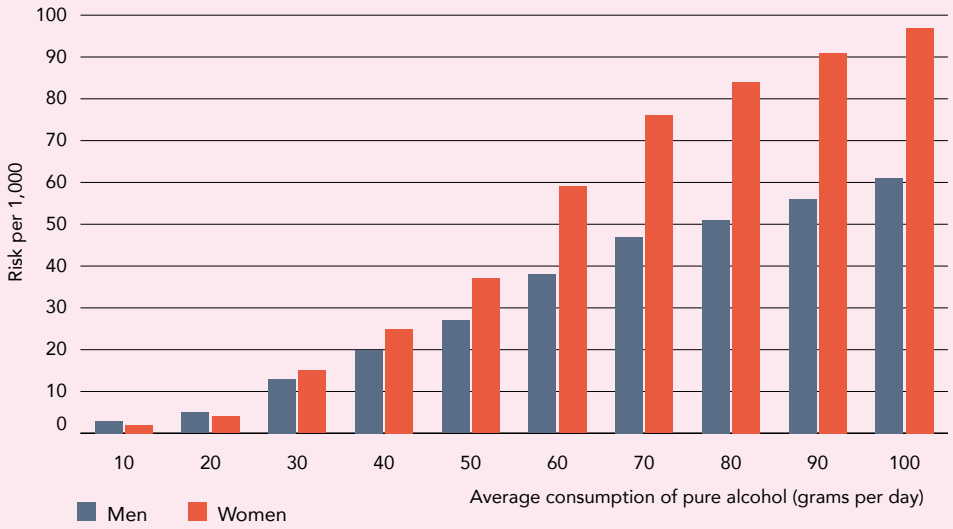
Consequences from binge drinking extend well beyond the individual drinker. Family violence, child neglect, lost productivity, crime, and health care costs are all closely tied to this drinking pattern. For Sweden, it is estimated that alcohol drinking reduces GDP by 2.3%[239] and costs around 103 billion SEK per year.[240]

8.4 Who is most at risk?

Those drinking more on a per occasion basis:

- **YOUNG PEOPLE:** More vulnerable due to brain development including poorly developed executive function.
- **WOMEN:** Risks of harms from binge drinking are greater for women than for men. Women are more affected physiologically by alcohol and (on average) weigh less, and they are also at higher risk of victimization.
- **MEN:** Men actually suffer more harms from binge drinking than women because they are more likely to binge drink, drink more per binge occasion, and may engage in more risk taking and aggression while impaired. As a result, men account for most impacts from binge drinking (e.g., those related to interpersonal violence and suicide)
- **LOWER-INCOME GROUPS**: Experience more severe harms even at similar or lower levels of drinking – the so-called "harms paradox."
- **FAMILIES:** Children of binge-drinking parents face emotional, developmental, and physical risks.

FIGURE 4 Lifetime risk per 1000 of overall chronic disease mortality by average daily alcohol consumption in grams per day of pure alcohol among men and women in Australia, 2002



Source: Figure 4 in Rehm et al. (2008). Method for moderation: measuring lifetime risk of alcohol-attributable mortality as a basis for drinking guidelines. Int J Methods Psychiatr Res. 2008;17(3):141-51

8.5 What works to reduce binge drinking?

Although binge drinking is common and dangerous, the good news is that there are many effective public policies that have been shown to reduce binge drinking and related consequences across the population. The main obstacle to public policy is political inaction abetted by efforts to undermine policy by vested interests. Ideally, effective public policies should be complemented with individual-level interventions.

- **POPULATION-LEVEL POLICIES**: Higher alcohol taxes, minimum unit pricing, restrictions on sales hours, reduced outlet density, and marketing limits.
- **LEGAL MEASURES:** Minimum drinking age laws, drink-driving enforcement, and liability laws for serving intoxicated patrons.
- **HEALTH INTERVENTIONS:** Brief counselling in health care settings, medications, and treatments for alcohol use disorder.
- **TECHNOLOGY:** Tools like ignition interlocks and alcohol detection systems in cars.

8.6 Key takeaway and recommendations

Binge drinking is a common and dangerous pattern of alcohol use. Binge drinking is not just a matter of "partying too hard" – it is one of the biggest contributors to alcohol-related disease, injury, and death, causing immediate harms and lasting health and social impacts. It harms not only the drinker but also families, communities, and health systems. Effective policies and interventions can reduce binge drinking and save lives, but they have not been adopted or implemented optimally.

Over the past 15-20 years, there has been a growing recognition of the adverse health effects at low average levels of alcohol consumption that might be considered 'moderate' from a social perspective. While this is important, high per-occasion consumption, with binge drinking (i.e., drinking to the point of acute impairment), remains ubiquitous, normalized and sometimes celebrated in Swedish society, as well as in other countries. In many cases it is considered a rite of passage, or as a means by which to spectate at a sporting event or to celebrate a family holiday. All of this is facilitated with massive expenditures on alcohol marketing, especially on social (digital) media, by companies profiting from the sale of alcohol and with a vested interest in maintaining the status quo.

Drinking patterns in Sweden and other Nordic countries are typically binge-drinking-oriented and have been so for a long time. In addition to a need for more and better public policies to support wellbeing with respect to alcohol, a cultural shift is in order. Adoption of effective policies can contribute to that cultural shift but also would be a by-product of a shift driven by political leaders and the public. This shift also needs to happen in health care.

In addition to a need for more and better public policies to support wellbeing with respect to alcohol, a cultural shift is in order

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