

## Science and society

### Alcohol: taking a population perspective

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**Abstract** Alcohol consumption is a global phenomenon, as is the resultant health, social and economic harm. The nature of these harms varies with different drinking patterns and with the societal and political responses to the burden of harm, nevertheless alcohol-related chronic diseases have a major effect on health. Strong evidence exists for the effectiveness of different strategies to minimise this damage and those policies that target price, availability and marketing of alcohol come out best, whereas those using education and information are much less effective. However, these policies can be portrayed as anti-libertarian and so viewing them in the context of alcohol-related harm to those other than the drinker, such as the most vulnerable in society, is important. When this strategy is successful, such as in Scotland, it has been possible to pass strong and effective legislation such as for a minimum unit price for alcohol.

This Perspective article may seem an unlikely topic for a clinical journal, but the wider harms of alcohol to health are increasingly being dealt with by gastroenterology and hepatology physicians. They need to know not just how to treat the individual's disease (and sometimes the underlying dependence), but also how to contribute to reducing the huge global burden of alcohol-related harm on individuals, those around them and society in general. We will show that the answers do not always lie in better healthcare, but in better health. It is telling that the UK is consistently rated top of the league of a range of developed countries for its healthcare (effectiveness, accessibility etcetera), but bottom of the league for its population's health.<sup>1</sup> This paradox arises because major threats to public health like alcohol need concerted policy action, often at a national level, to tackle issues quite independent of healthcare delivery like price, marketing and availability. Our governments are either insufficiently bold or too influenced by the alcohol industry to follow the evidence on these key issues. The public health approach also serves to emphasise that alcohol harm is not just about the small minority of dependent drinkers. The cumulative harm in those not considered 'problem drinkers', whether it be in cancers, heart disease or other illness, is huge and will be missed without a population perspective. Clinicians need to become advocates for the populations they serve as well as for their patients.

This Perspective will outline the scale of the global alcohol problem, the wide ranging effects of alcohol, and the most effective evidence-based strategies to effect a population level reduction in harm. We will also highlight how clinicians can be good public health advocates and what downstream strategies there are while we wait for governments to take the necessary action.

## **[H1] The scale of the problem**

### **[H2] Global alcohol consumption**

The quantity and pattern of alcohol use varies enormously between drinkers, between countries and within countries. National consumption level estimates are typically presented as the volume of pure alcohol consumed per adult per year, and the source of these data tends to be official statistics related to the sale of alcohol (for example, taxation records, customs data, surveys of producers and distributors). However, not all alcohol that is available for consumption is recorded in official statistics owing to varying levels of unregulated

production, which tends to be particularly high in developing countries, and also unregulated importation.<sup>2</sup>

The most recent global data are the 2010 estimates published by the WHO (World Health Organization), which take into account recorded alcohol and an estimate of the unrecorded alcohol based on country specific intelligence. The highest levels of per capita consumption are seen across Eastern Europe and Russia and the lowest levels across the predominantly Islamic countries of North Africa, the Middle East and Southeast Asia (Figure 1). Annual per capita consumption is 11.6 litres in the UK, 12.2 litres in Australia, 10.2 litres in Canada and 9.2 litres in the USA. Over the past 50 years the UK has seen a substantial increase in consumption from relatively low levels compared with some of its neighbouring European countries, such as France and Italy, which have seen substantial decreases from very high levels (Figure 2).<sup>3</sup>

Data collected through population level surveys have been found to vastly underestimate levels of alcohol use, and are not sufficient to monitor national consumption levels, but they are crucial in informing governments about differing patterns of consumption.<sup>2</sup> When national consumption figures are adjusted to account for numbers of nondrinkers (derived from population surveys), it is generally observed that countries with low levels of adult per capita consumption have relatively high levels of consumption per drinker.<sup>3</sup> Comprehensive reviews of the literature<sup>4,5</sup> highlight that studies drawing on survey data have shown that a high proportion of the alcohol consumed in a country is consumed by a relatively small number of heavy drinkers (Box 1), and that as a country's total consumption increases so does the level of heavy drinking. Even among people with moderate levels of consumption, a high proportion of alcohol is consumed during binge drinking occasions. These reviews<sup>4,5</sup> have also shown how alcohol consumption varies by age, gender and socio-economic status in the developed world. Although the gender gap is narrowing, more males drink alcohol than females and among those that do drink, males consume larger quantities and more frequently than females.<sup>4,5</sup> Younger people are more likely to engage in binge drinking, and older people are more likely to drink daily.<sup>4,5</sup> Those in higher socioeconomic strata are more likely to drink and tend to drink more frequently compared with lower socioeconomic groups.<sup>4,5</sup> It is important that clinicians stay abreast of which populations are most at risk helping maximise the effect of the preventative approach by targeting high risk groups as well as entire populations.

## **[H2] Global burden of alcohol consumption**

Alcohol is associated with a large range of health conditions and ranks as the fifth leading risk factor for disease and injury worldwide. Among 15–49 year olds alcohol consumption is the leading risk factor for premature death and disability.<sup>7</sup> Furthermore, in developed nations alcohol causes similar or greater harm to others than harm to users themselves.<sup>8</sup>

The WHO estimates that in 2012, 139 million disability-adjusted life years (DALYs), years of healthy life lost through disability and premature mortality, were attributable to alcohol use globally (5.1% of all DALYs). Injuries (intentional and unintentional) were the top contributor followed by neuropsychiatric disorders, cardiovascular diseases and gastrointestinal diseases.<sup>3</sup> Similar to levels of alcohol use, the associated burden of disease and injury differs by region of the world, broadly following the global distribution of per capita consumption (Figure 1). The highest burden is seen across Eastern Europe and Russia and the lowest across North Africa, the Middle East and Southeast Asia.<sup>3</sup> The burden of disease attributable to alcohol is above the global estimate of 5.1% in the UK, Canada and the USA, but below that in Australia.<sup>3</sup> In keeping with the trend in alcohol consumption in the UK (Figure 2), morbidity and mortality from liver disease and other alcohol-related disorders are also on the increase.<sup>9</sup>

Not only is alcohol use associated with health outcomes but there are wide ranging social and economic consequences. The annual financial burden of alcohol on society, through healthcare, policing, absenteeism and other social problems is difficult to quantify but has been estimated at around CA\$14.5 billion in Canada (~\$463 per capita),<sup>10</sup> GB£21 billion in the UK (~£40 per capita),<sup>11</sup> AU\$35 billion in Australia (~ \$1,743 per capita)<sup>12</sup> and US\$249 billion in the USA (~\$807 per capita).<sup>13</sup>

## **[H1] The effects of alcohol**

The magnitude of health, social and economic consequences experienced by drinkers themselves, other individuals and society at large is influenced not only by the quantity of alcohol, but also the way in which it is consumed (Figure 3). Individual and societal factors, including alcohol policies and regulations, also have a large influence on the type and magnitude of problems associated with alcohol.<sup>3</sup>

The relationship between alcohol consumption, disease and injury is complex. The literature on the health effects of alcohol consumption is dominated by observational rather than experimental studies, and meta-analyses of observational studies make up the bulk of the evidence-base showing a consistent dose-response relationship that has then led to causation being established through the process of comparative risk assessment.<sup>14,15</sup> It is usual practice to have credible evidence, ideally from experimental studies, of a plausible biological mechanism to underlie causal associations between alcohol use and disease or injury.<sup>16,17</sup> Experimental ‘feeder’ studies (where alcohol is administered) have mainly focused on short-term outcomes, such as serum biomarkers for coronary heart disease or cognitive and psychomotor effects that increase the risk of injury. There have been no long-term randomised controlled trials (RCTs) examining risk of death due to alcohol exposure in this field.

For many of the observed social and economic effects associated with alcohol consumption, such as domestic or work-life problems and societal costs, it is only correlation not causation that has been established.<sup>4</sup>

## **[H2] Health effects**

Alcohol use is associated with a range of health conditions, either directly or as a component cause. These include conditions that arise in the short-term from acute alcohol intoxication or in the long-term from cumulative exposure to alcohol. However, some conditions do not fit neatly into these categories. For example, alcoholic gastritis is an acute presentation, but is more common among regular heavy drinkers. Evidence exists for both causative and protective effects of alcohol on health outcomes.

### **[H3] Short-term effects**

*[H4] Intoxication and poisoning.* The short-term intoxicating effect of alcohol has been experienced for as long as it has been consumed. Increased blood alcohol concentration, when the rate of consumption has exceeded the rate at which the liver processes ethanol, causes both mental and physical impairment even at low levels. At high levels the intoxicating effect can directly culminate in coma or death.<sup>19</sup>

*[H4] Injuries to self and others.* The mental and physical impairment caused by alcohol intoxication in the short-term has been causally related to an increased risk of unintentional and intentional injury. A dose-response relationship has consistently been observed for injuries from road traffic crashes, falls, fires, drowning, work-related accidents, violence and self-harm.<sup>17,20</sup>

### **[H3] Long-term effects**

*[H4] Gastrointestinal and hepatic diseases.* Alcohol use has consistently been causally associated with alcoholic gastritis, gastro-oesophageal haemorrhage, both acute and chronic pancreatitis, and the development and progression of liver disease (from fatty liver disease through to advanced cirrhosis and associated complications such as oesophageal varices).<sup>16</sup> The relationship between increasing average daily consumption and the incidence of and mortality from cirrhosis and pancreatitis is exponential.<sup>21,22</sup> The rise in cirrhosis mortality has been so striking in the UK over the past 20 years that it is likely that the effects of alcohol and obesity (also on the rise) combine to produce a ‘double hit’ on the liver.<sup>9</sup> A protective effect of alcohol use on cholelithiasis has been suggested.<sup>23</sup>

*[H4] Neuropsychiatric conditions.* A range of neuropsychiatric conditions directly attributable to heavy alcohol use have been identified including alcohol dependence syndrome, alcohol withdrawal state, alcoholic myopathy<sup>16</sup> and alcohol-related brain damage.<sup>24</sup> Meta-analyses of observational studies have also confirmed a dose-response relationship between alcohol use and risk of epilepsy,<sup>17</sup> including unprovoked epileptic seizures independent of seizures related to alcohol withdrawal.<sup>25</sup> Another neuropsychiatric condition considered to have a partially attributable causal relationship with alcohol use is unipolar depressive disorder; however, it is generally not included in burden of disease estimates associated with alcohol due to confounding factors.<sup>17,26</sup>

*[H4] Cardiovascular diseases.* Alcohol use has been well established as a component cause in cardiac arrhythmias, hypertensive disease, coronary heart disease and stroke, with increased risk generally seen for high levels of consumption.<sup>17,27</sup> At low to moderate levels of consumption the evidence is mixed. Meta-analyses of short-term experimental and observational studies conclude that low to moderate levels of alcohol consumption are protective against hypertensive disease in women (but not men),<sup>28,29</sup> coronary heart disease,<sup>30,31,32</sup> ischaemic stroke, and haemorrhagic stroke in women.<sup>33</sup> However, binge

drinking occasions once a month or more have been shown to negate any protective effect from low level drinking on coronary heart disease,<sup>34</sup> and a RCT published in 2015 reported that regular low levels of alcohol consumption increases the risk of hypertension among women.<sup>35</sup> In addition, Mendelian randomisation studies that more closely replicate RCTs than traditional observational studies have brought into question the veracity of the apparent protective effects of alcohol against cardiovascular disease, as well as several key hypothesised causal mechanisms.<sup>36,37</sup>

*[H4] Cancers.* The International Agency for Research on Cancer classifies alcohol as a group 1 carcinogen (carcinogenic to humans), and considers alcohol to be causally related to cancers of the oral cavity, pharynx, larynx, oesophagus, liver, colon, rectum and female breast. Of these, colorectal and female breast cancers were the most recent to be judged causally related to alcohol in 2007.<sup>38</sup> The relative risk of developing these cancers increases with any and with increasing average daily alcohol consumption. Other cancers for which a significant association with alcohol use has been found, but currently insufficient evidence for causality exists, include gastric, pancreatic, lung and prostate cancer.<sup>39,40</sup> In the case of prostate cancer, new evidence assembled in the past several years is likely to lead to a consensus on causality in the near future.<sup>41,42</sup>

*[H4] Diabetes.* Another condition that moderate average alcohol consumption has been associated with protection against in both experimental and observational studies is type 2 diabetes mellitus. Similar to coronary heart disease, meta-analyses of studies have displayed a j-shaped curve with an increased risk of type 2 diabetes only at higher doses.<sup>43,44</sup> Uncertainty surrounds the observed protective effect, with healthy lifestyle choices among moderate drinkers possibly confounding the results.<sup>17,27,45</sup>

*[H4] Perinatal conditions.* Fetal alcohol spectrum disorder is a prime example of harm experienced by an individual other than the drinker.<sup>19</sup> High levels of alcohol consumption during pregnancy (particularly the first trimester) have also been linked to spontaneous miscarriage,<sup>23</sup> preterm birth and conditions related to preterm birth such as low birth weight.<sup>17,46</sup> Epigenetic mechanisms whereby parental exposure to alcohol can alter subsequent gene expression in their offspring are also emerging.<sup>47</sup>

*[H4] Infectious diseases.* In 2008, international experts met in Cape Town to review the evidence regarding the association between alcohol and two infectious diseases, HIV and tuberculosis. They concluded that sufficient evidence exists for a causal association between high levels of alcohol consumption and the incidence of tuberculosis, and the progression of existing tuberculosis and HIV.<sup>48</sup> Meta-analyses and systematic reviews conducted since have confirmed the relationship between alcohol and tuberculosis<sup>49</sup> and HIV,<sup>50</sup> and added community-acquired pneumonia to the infectious diseases that alcohol is considered causally related to.<sup>17,51</sup>

## **[H2] Social and economic effects**

In addition to the health effects that alcohol is known to have on the individual drinker, a wide range of harms are inflicted on others and the burden on society at large needs to be considered.<sup>8</sup> A bystander, friend, colleague or family member could be injured through violence or an accident,<sup>20</sup> or an unborn child harmed by its mother's drinking during pregnancy.<sup>19</sup> Families might be affected financially or through neglect, workplaces by decreased productivity and absenteeism, and whole communities by crime, disorder and the public money spent on alcohol-related healthcare and policing.<sup>12,52</sup> The epidemiological evidence base surrounding the social and economic effects of alcohol consumption is quite weak,<sup>4</sup> but the direct and indirect effects are likely to be wide ranging. Consideration of them is needed if policy makers are to understand the full scale of the effects of alcohol use on society.

## **[H1] An evolving field of study**

Unfortunately, the scientific study of the effects of long-term exposure to alcohol suffers from a number of uncertainties, and current burden-of-disease estimates are likely to be an underestimation. This underestimate is particularly true for effects of low levels of alcohol consumption, in which outcomes might have long latency periods, be influenced by multiple risk factors, and have low relative risk estimates compared with other risk factors. The possible confounding effects of other risk factors associated with alcohol consumption that have independent associations with disease risks can lead to underestimating the disease risks from alcohol use, for example when moderate drinking is associated with a generally moderate lifestyle.<sup>53</sup>



Although confounding factors could also result in overestimation, many other uncertainties exist that result in an underestimation of disease risks and, by corollary, an overestimation of the potential health benefits of alcohol. Systematic bias can operate in longitudinal studies in several ways that lead towards alcohol consumers looking healthy in comparison with abstainers. The definition of the all-important comparison group, ‘abstainers’, differs widely from study to study and might include people who are only known to have recently abstained, who usually abstain or who are former drinkers. Individuals who greatly reduce their drinking or stop completely often do so for health reasons.<sup>54,55</sup> These issues mean that with passing time, the comparison group of ‘abstainers’ increasingly fills with less healthy people while drinker groups (particularly low and moderate drinkers) are increasingly made up of relatively healthy survivors. A further complication is that even young adults who become complete abstainers often have poorer health than their peers who become drinkers.<sup>56</sup> There is now greater awareness of the need to control for these kinds of methodological problems in longitudinal studies of possible health protective effects of low dose alcohol,<sup>54,57,58</sup> but it has been argued that the bulk of epidemiological literature on alcohol remains affected by bias and confounding factors,<sup>59</sup> the effect of which has not been fully quantified.

In addition to causing substantial underestimation of the burden of disease from alcohol, the methodological problems described above pose difficulties for the formulation of national low risk drinking guidelines. In some countries such as Canada, these have been set at a level where the relative risk of all-cause mortality for alcohol consumers equals that of abstainers (135g of ethanol per week for women and 202g for men).<sup>60</sup> The potential risks and benefits of alcohol use below this level are thought to cancel each other out or are a net positive. The approach in Australia was to use absolute risk estimates and discount potential benefits of low-volume alcohol consumption.<sup>19,61</sup> Others have suggested setting limits at the level of drinking at which mortality risk begins to increase, regardless of whether there may be net benefits at this level.<sup>62</sup> As research in this complex area evolves it can be confidently concluded that recommendations for acceptable ‘low risk’ consumption will become more conservative. For example, the UK alcohol guidelines released in early 2016 recommend that both women and men do not regularly exceed 112g of ethanol per week and have several drink-free days each week.<sup>63</sup> The Joint Action on Reducing Alcohol Related Harm (RARHA) across European Union member states is the most coordinated international effort to discuss low risk guidelines to date.<sup>64</sup>

Based on the current state of the evidence, any published guidelines relating to alcohol use should discourage drinking alcohol for health benefits, and clinicians should not recommend alcohol consumption to their patients as a means of reducing cardiovascular or other disease risk.<sup>59</sup>

## **[H1] Reducing alcohol-related harm**

As alcohol is an addictive substance and because the negative consequences of alcohol consumption are often second-hand, with the costs borne by societies as a whole, government regulation is required to discourage problematic consumption and associated behaviour and to protect others from harms caused by drinkers.

Babor *et al.*<sup>4</sup> describe how authority over and possibilities for regulating alcohol exist at multiple levels of government. Alcohol policy tends to be decentralised, with responsibilities for different aspects of policy spread among what are sometimes competing government interests, such as health ministries and revenue or finance agencies. Government control over alcohol can extend to the production, export, and import of alcoholic beverages; wholesaling and/or retail sale of alcohol; establishment of minimum legal purchase ages for alcohol; measures to reduce drink-driving; restrictions on alcohol marketing; and support for and standards for prevention and treatment services and activities. Although the locus of control over alcohol policy-making in many countries lies at the national level, opportunities for regulation at the local level (for example, as is the case in England where local authorities have control of alcohol licensing) are also possible. A divergence of policy within the constituent UK countries provides the chance to compare the impact of different policies.<sup>65</sup> In federal systems, such as the USA, Canada and Australia, control can be divided between national and state or provincial authorities. Natural experiments in the privatisation of government monopolies over retail alcohol sales in the USA, Canada, Finland and Sweden have illustrated the health and safety benefits of government regulation: in general, privatisation has led to greater consumption and alcohol-related problems, whereas renationalisation has reduced harms.<sup>66,67</sup>

Alcohol sales worldwide total approximately US\$ 1trillion annually,<sup>68</sup> and for beer and spirits in particular, a small number of companies dominate global markets.<sup>69</sup> These companies are known to play an active role in alcohol policy formation, and have generally been found to

support policies with the weakest evidence of effect, and oppose those likely to have greater effect on reducing consumption and harms.<sup>70,71</sup>

The most effective means of reducing excessive alcohol use and related problems at the population level is through policies that reduce the affordability and/or availability of alcohol and restrict alcohol marketing.<sup>4,72</sup> Educational efforts alone that seek to change individuals' drinking behaviour have been largely unsuccessful, and although treatment of alcohol dependence is important, clinical addiction treatment has not been shown to result in population level reductions in harm.<sup>4</sup>

## **[H2] Reducing alcohol affordability**

Evidence supports the effectiveness of reducing the affordability of alcohol as the single strongest intervention to have been evaluated for the reduction of population levels of alcohol related harm. This is the conclusion of multiple comprehensive reviews<sup>4,73,74</sup> and is confirmed by several meta-analyses and natural experiments. For example, Wagenaar *et al.*<sup>75</sup> identified 112 higher quality international studies incorporating >200 years of data and generating 1003 estimates of the relationship between alcohol prices and consumption levels. They concluded that a 10% increase in price led to an average 4.4% reduction in total population consumption. Other studies also suggest that price increases specifically for cheap alcohol will result in greater reductions in the consumption of heavy drinkers than low or moderate drinkers.<sup>76,77</sup>

Unfortunately, in contrast to education and persuasion strategies, across-the-board alcohol pricing and tax increases are among the most unpopular policy options with the general public<sup>78</sup> and are more unpopular in heavier drinking populations.<sup>79</sup> In other words, greater need for effective pricing policies can render them more politically dangerous for decision-makers. In response to this dilemma, we highlight some more targeted approaches to alcohol pricing, such as minimum unit pricing,<sup>76</sup> which might be more palatable to the general public and decision-makers.

The two most common arguments against pricing strategies are first, that the heaviest and dependent drinkers will be unaffected and second, if affected these drinkers might turn to more dangerous forms of non-beverage alcohol. Neither argument stands up to scientific

scrutiny and is contradicted by the evidence summarised below. If price increases were leading drinkers simply to substitute beverage alcohol for non-beverage alcohol, it would not be possible to observe the kinds of reductions in alcohol-related mortality and morbidity shown to be associated with tax increases.<sup>80,81</sup>

Pricing and taxation strategies need to be the first priority of any comprehensive response to alcohol-related problems. In combination they can produce increased revenues for government and industry, while reducing consumption and harms. The challenge is finding the balance where governments and industry can agree. Societies that allow unfettered access to very cheap alcohol will undermine the effectiveness of other prevention and treatment strategies. However, pricing and taxation strategies rely on control of the unregulated market for their effectiveness, which is not always the case particularly in low-income and middle-income countries.

### **[H3] Linking alcohol prices to the cost of living**

Mechanisms to periodically adjust taxes and prices to keep up with the cost of living are important to ensure the preventive power of alcohol pricing is not eroded, particularly where alcohol taxes are tied to the volume of the beverage, as they are in many jurisdictions. A lack of adjustment has been a substantial problem in the USA, where the federal tax on beer has been raised just once in >50 years.<sup>82</sup> In Canada raising alcohol excise duty requires the consent of Parliament and has only been done twice in 25 years.<sup>83</sup> The UK Government introduced an alcohol duty escalator in 2008, to keep the excise rate 2% above the rate of inflation, only to abolish it in 2014.<sup>84</sup> By contrast, in Australia alcohol excise taxes are raised every six months with the cost of living so that their real values are maintained.<sup>85</sup> Failure to maintain prices and tax levels allows downward pressure on the price of alcohol and hence upward pressure on population levels of consumption and related harm.

### **[H3] Minimum pricing**

Minimum pricing refers to a set price below which alcoholic beverages cannot be legally sold in the retail market. The 10 Canadian provinces are among a handful of jurisdictions that set minimum prices for the sale of alcohol. Usually, these are set independently of alcohol content and do not keep pace with inflation, which guarantees at least a small number of very cheap high strength products remain, for example, 8% alcohol by volume beer, 22% fortified wine and 75% spirits.<sup>86</sup> Nonetheless, Canadian researchers have estimated the associations

between changes in minimum alcohol prices, consumption and related harms. In these studies it is estimated that a 10% increase in minimum alcohol prices is associated with a 9% reduction in alcohol-related hospital admissions,<sup>87</sup> a 32% reduction in wholly alcohol caused deaths,<sup>88</sup> and a 9% reduction in violent crime.<sup>89</sup>

### **[H3] Pricing on alcohol content**

Ethanol is the ingredient in beverage alcohol that, in a dose-response manner, causes serious health and safety problems. The provincial health officer of British Columbia, Canada has recommended ethanol-based pricing within each main category of alcoholic beverage,<sup>90</sup> and an increasing number of Canadian provinces including Saskatchewan, Ontario, Quebec and Manitoba are now following this recommendation.<sup>91</sup> A marked increase in the minimum prices charged for higher strength beers in Saskatchewan was shown to trigger a shift from high to low strength wines and beers and an overall reduction in per capita consumption.<sup>92</sup>

### **[H3] Minimum unit pricing**

A public health ideal, combining both the previous two objectives, would be to have a single set of taxation rates based entirely upon ethanol content and with set minima (that is, minimum unit prices), which would remove the myriad different rates of tax typically applied to alcoholic drinks.<sup>93</sup> The UK proposals<sup>11</sup> passed into law in Scotland but not yet implemented,<sup>94</sup> link the minimum price directly to the alcohol content. UK modelling studies have suggested that raising minimum alcohol prices to only 45 pence per unit/standard drink would substantially reduce alcohol-related deaths and healthcare costs.<sup>76,95</sup>

### **[H3] Earmarked alcohol taxes**

The unpopularity of raising the price of alcohol via taxation to reduce problems can be offset if the rationale provided involves raising revenue to pay for treatment and prevention programs.<sup>93</sup> Such earmarked or ‘hypothecated’ taxes have been introduced in a number of countries variously for alcohol, tobacco and gambling. Such special taxes have the twin virtues of reducing harm while generating extra revenues.<sup>96</sup> As demand for alcohol is relatively ‘inelastic’, increased taxes will almost invariably result in increased revenues for government.<sup>97</sup>

### **[H3] Combining taxation**

Thailand has adopted an approach to alcohol taxation that calculates the tax on various types of alcoholic beverages both by alcohol content and as a fixed percentage of the price and then applies the higher of the two as the actual tax. This method results in higher taxes both on the beverages most popular with heavier drinkers (high alcohol content, but lower price per drink) and those attractive to young and inexperienced drinkers (lower alcohol content, but higher price per drink), leading to lower consumption overall.<sup>98,99</sup>

### **[H3] Restricting discounts**

Restrictions on discounts can include bans on ‘happy hours’ in on-premise outlets (pubs and bars) and ‘buy one get one free’ promotions in off-premise outlets (supermarkets, off-licences, liquor stores). Evidence of effectiveness in this area is relatively limited, with the majority of studies from the USA, but it is a growing area of interest.<sup>100,101</sup> Scotland introduced a total ban on alcoholic beverage discounts in on-premise outlets in 2009,<sup>102</sup> and on multi-buy discounts in off-premise outlets in 2011.<sup>103</sup> Modelling by Meng *et al.*<sup>104</sup> estimated that a total ban on off-premise discounts in Scotland would reduce overall alcohol consumption by 3%. Two evaluations of the off-premise multi-buy promotion ban have shown contradicting results. One that the ban had no impact on off-premise alcohol purchases<sup>105</sup> and the other that the ban was associated with a 2.6% reduction in off-premise alcohol sales in Scotland.<sup>106</sup>

## **[H2] Reducing physical availability**

Reducing the physical availability of alcohol relates to increasing the ‘convenience’ cost of alcohol by regulating the times, places and contexts in which it can be obtained.<sup>107</sup> This approach can range from total or partial prohibition through to secondary supply laws that prevent adults supplying alcohol to underage drinkers. The areas for which most evidence exists for reducing population level harm are restricting trading hours, limiting outlet density and having older minimum purchasing age laws.<sup>4</sup>

### **[H3] Restricting trading hours**

Strong evidence shows that large changes (for example, adding or subtracting a whole day) in the trading hours of on-premise outlets can influence rates of consumption and harm.<sup>4</sup> The literature on the effects of increasing or reducing trading hours at first appears conflicting.

However, a comprehensive review assessed 49 studies on two key criteria: whether a control area was used for comparison and whether baseline data were collected.<sup>108</sup> The majority of studies meeting these criteria found increased hours resulted in increased harms, such as assaults and drink driving offences. A review by Hahn et al.<sup>109</sup> concluded that restricting hours of sale by two hours or more was likely to reduce alcohol-related harms, and since then three additional high-quality studies have demonstrated reductions in violent incidents following small reductions in trading hours.<sup>110,111,112</sup>

### **[H3] Limiting outlet density**

The evidence linking the density of different kinds of alcohol outlets (for example, number of outlets per 10,000 residents or per km<sup>2</sup>) with rates of both alcohol consumption and alcohol-related harm is somewhat mixed. Two systematic reviews assessing studies published prior to 2009<sup>113,114</sup> concluded that limiting alcohol outlet density was an effective measure in reducing alcohol consumption and related harms. Evidence appears to be more developed and strongest for outlets that sell alcohol for on-premise consumption versus off-premise consumption. A 2015 systematic review focusing on literature from 2009 to 2014,<sup>115</sup> although still concluding that restricting outlet density might reduce alcohol-related harms, has been critical of methods used in outlet density studies and of the conclusions drawn in the earlier reviews. This review is somewhat contentious and has been the topic of commentary by other experts in the field.<sup>116</sup>

### **[H3] Purchasing age laws**

Convincing evidence from studies of the impact of both increases and decreases in legal drinking ages show that higher legal drinking ages are associated with fewer road traffic crashes involving young people than lower ages.<sup>4,117</sup> Studies have also demonstrated the effectiveness of enforcement strategies that restrict the access of underage drinkers to alcohol.<sup>118</sup> Both the legal age of purchase and the extent to which this law is enforced will limit access by underage drinkers and potentially reduce harm to this specific group who are at a very high risk for a range of alcohol-related problems.<sup>119,120</sup>

## **[H2] Restricting alcohol marketing**

Alcoholic beverages are promoted extensively around the world. In the USA alone, 14 alcohol companies spent US\$3.4 billion on marketing in 2011<sup>121</sup> and alcohol companies are

among the ten leading advertisers in numerous low-income and middle-income countries.<sup>122</sup> Beyond traditional advertising, contemporary alcohol marketing encompasses point-of-sale advertising, sponsorship of sporting and other events and celebrities, promotional allowances and other incentives to retailers, internet advertising and social media, product placement, and social responsibility programs and messages. Particular products or marketing campaigns might be perceived to target women or vulnerable populations such as young people or lower socioeconomic groups.<sup>123,124</sup>

A substantial and growing body of research literature has found that youth exposure to alcohol marketing is associated with greater likelihood of initiation of drinking, and with increased alcohol consumption among young people who have already begun to drink. Published systematic reviews have identified 13 longitudinal studies,<sup>125,126</sup> and subsequent literature searches have identified at least eight others, all of which have found the association described above,<sup>127</sup> however, the effect sizes are modest. All the longitudinal studies to date have examined associations between alcohol marketing exposure and consumption of alcohol in general or consumption by alcohol type. In recognition of the branded nature of alcohol marketing and consumption, some cross-sectional work has focused on exposure and consumption by alcohol brand, finding much stronger associations.<sup>128</sup>

In comparison with other interventions to reduce alcohol-related harm, advertising and marketing restrictions have consistently been found to be highly cost-effective.<sup>73,129,130</sup> Although no studies to date, of which we are aware, have examined the effectiveness of specific policy initiatives to reduce alcohol marketing, multiple studies have used modelling to assess the effect of such reductions in alcohol marketing on health outcomes at the population level.<sup>129,131</sup>

### **[H3] Self-regulation**

The most common form of regulation of alcohol marketing worldwide is alcohol industry self-regulation;<sup>3</sup> however, numerous studies from multiple countries have shown this form of regulation to be ineffective either in protecting young people from disproportionate exposure to alcohol marketing<sup>132,133</sup> or in restricting objectionable advertising content.<sup>134,135</sup>



### **[H3] Total or partial bans**

The most effective and cost-effective approach to reducing alcohol marketing exposure among populations is a total ban on alcohol marketing, which is relatively easy to implement, except when it comes to digital media that cross national borders.<sup>129</sup> The Loi Évin<sup>4,136</sup> law in France, passed in 1991 and named after health minister Claude Évin, offers a model for partial bans by prohibiting all marketing activities and then writing exceptions to that prohibition, thereby requiring that all new marketing innovations be approved by Parliament. Partial bans might include restrictions on content, such as limitations on lifestyle advertising or restricting marketing communications solely to product qualities; time-specific bans such as time watersheds permitting alcohol advertising at certain times of day; audience-specific bans such as restrictions on marketing in youth venues or in media more likely to be attended to by young people than adults; other specific bans relating to the type of beverage, the advertising medium and television channels, such as no advertising of distilled spirits on national free-to-air television, or on channels popular with young people such as MTV© (Viacom International Media Networks Europe); and bans specific to geographical location and events, for instance restricting alcohol advertising in proximity to schools or playgrounds or at sporting events.

Implementation of anything short of a total ban requires the creation of a monitoring function. Commercial data sources might be useful in assessing the degree to which standards to prevent disproportionate exposure of young people are being followed; however, these data sources can be expensive and require specialised expertise if they are to be properly employed.<sup>137</sup> France provides a model for incentivising public monitoring and enforcement of its ban, through a provision that permits nongovernmental organisations to bring legal action in the courts and be awarded resulting fines when they can show the law is being violated.<sup>138</sup>

### **[H3] Counter-advertising**

Finally, counter-advertising is an alternative or addition to the regulation of alcohol marketing. Although mandated government counter-advertising has been shown to be effective in reducing youth smoking,<sup>139</sup> this approach remains largely untested in the case of alcohol marketing.

## **[H1] So, what does the future hold?**

Clearly, alcohol causes a huge preventable burden on global health, the biggest single preventable factor in premature death and disability in adults aged 15–49,<sup>7</sup> and we have evidence-based strategies to reduce this burden. Whether governments have an appetite for the regulatory measures that work is less clear, and with the increasing influence of global alcohol producers there is need for international action comparable to the WHO Framework Convention on Tobacco Control.<sup>140</sup> Implementing such a framework will require shifting public opinion to allow such action, and here the recognition of alcohol as a major harm to innocent bystanders, particularly children, is key. The emerging data on alcohol as a cause of common cancers will also be important to influence public opinion. Indeed, information and education might be more effective in creating support for effective public health policy rather than directly changing individual behaviour.<sup>141</sup> Scientists and clinicians are most likely to have a role in these areas to rebalance our troubled relationship with society's favourite drug.

As we wait for our public health advocacy to be heard and for governments to take the necessary action what can clinicians do? As well as continuing to advocate for policy action, they should remember that identification and treatment of individuals is effective across the spectrum of problem drinking, from early identification and brief advice through to treatment services for established dependence.<sup>4</sup>

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### **Author contributions**

All authors contributed equally to all aspects of this manuscript.

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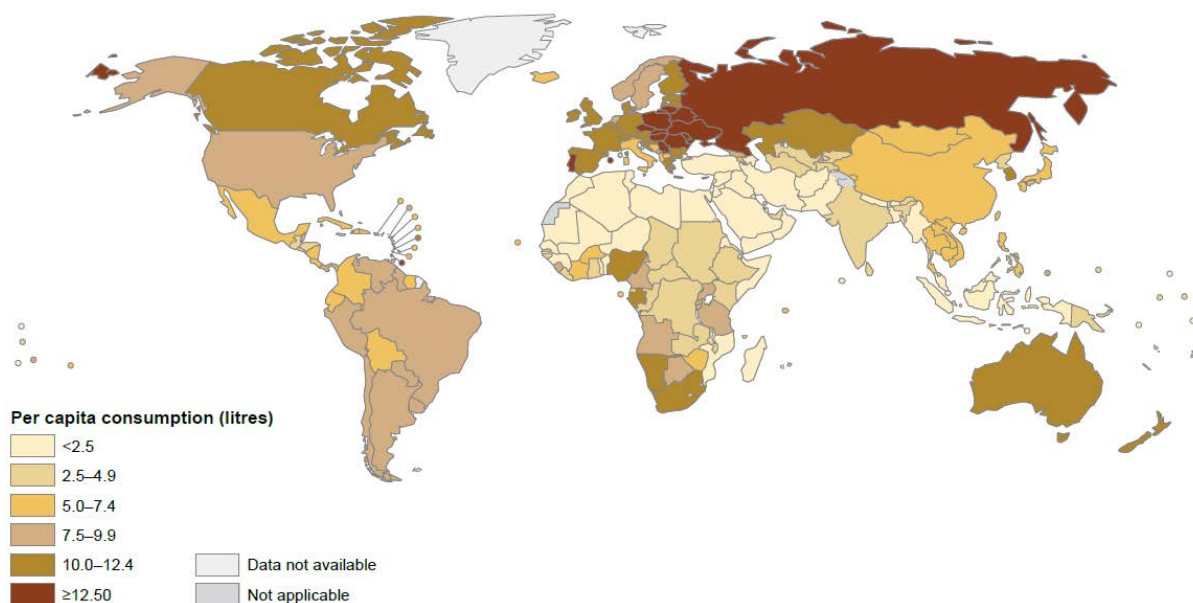


Figure 1. Litres of pure alcohol (recorded and unrecorded) consumed per person aged 15 years and over, 2010. World Health Organization, 2014.<sup>3</sup>

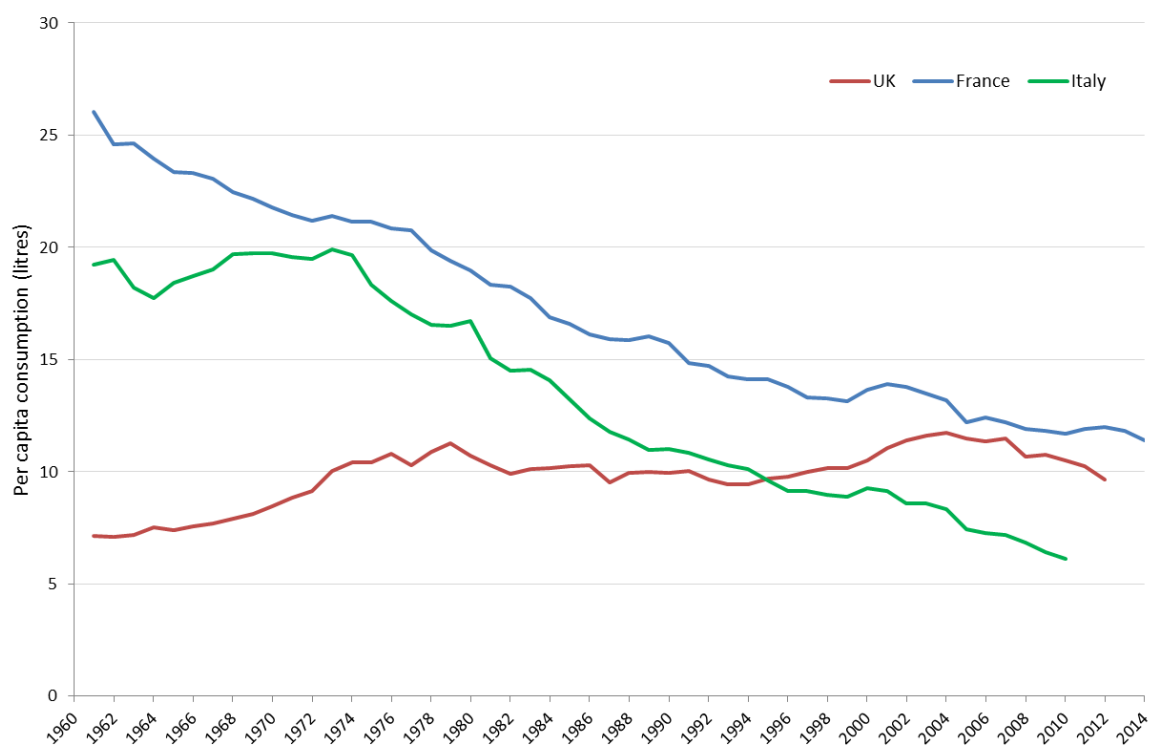
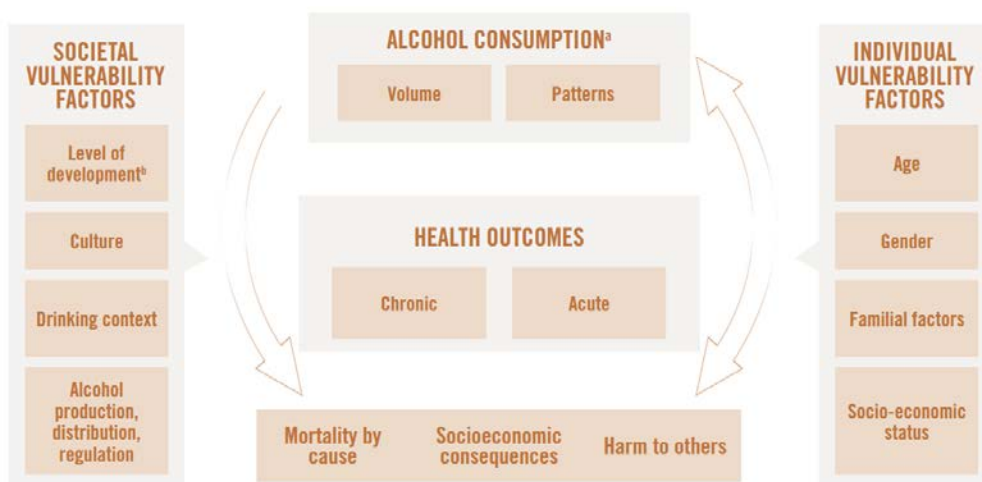


Figure 2. Litres of pure alcohol (recorded) consumed per person aged 15 years and over in the UK (1961-2012), France (1961-2014) and Italy (1961-2010). World Health Organization, Global Information System on Alcohol and Health.<sup>6</sup>



<sup>a</sup> Quality of the alcohol consumed can also be a factor

<sup>b</sup> Development of health and welfare system, and economy as a whole

Figure 3. Conceptual causal model of alcohol consumption and health outcomes. World Health Organization, 2014 (based on Rehm et al., 2010 and Blas et al., 2010).<sup>3,15,18</sup>

### Box 1. Alcohol consumption levels defined?

Definitions and terminology regarding different levels and patterns of alcohol consumption vary substantially between countries, between studies, and over time.

Broadly speaking, country definitions align with the existing national drinking guidelines with 'low' or 'moderate' levels referring to consumption within the limits set for low risk drinking and 'heavy' levels referring to consumption exceeding those limits. In the UK this limit is currently set at 112 grams of pure alcohol per week for both men and women.<sup>63</sup>

A 'binge' drinking occasion refers to a pattern of consumption over a relatively short period of time that results in impairment. The WHO refers to this as heavy episodic drinking, defined as drinking in excess of 60 grams of pure alcohol on a single occasion.<sup>3</sup>

Box 1. Alcohol consumption levels defined?