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Binge drinking: Health impact, prevalence, correlates and interventions

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Objective: Binge drinking (also called heavy episodic drinking, risky single-occasion drinking etc.) is a major public health problem. This paper provides an overview of recently published evidence concerning the definition and measurement, prevalence rates, health impact, demographic and psychosocial correlates of, and interventions for, binge drinking.

Design: Narrative review.

Results: Mostly occurring among young people at weekends, binge drinking increases the risk of both acute (e.g. injuries) and long-term negative consequences (e.g. alcohol disorders). Binge drinkers tend to be extrovert, impulsive and sensation-seeking. Stress, anxiety, traumatic events and depression are also related to binge drinking. Both alcohol-related behaviour of parents and general parenting (e.g. parenting styles, monitoring) are also important. Other major risk factors for binge drinking are frequently spending time with friends who drink, and the drinking norms observed in the wider social environment (e.g. school, community, culture). Emergency departments, birthday parties, fraternities and the workplace serve as settings for interventions; these are increasingly delivered via digital and mobile technology. There is evidence of small-sized effects across approaches (brief interventions, personalised normative feedback, protective behavioural strategies etc.) and populations.

Conclusion: A more consistent terminology, investigating multi-level influences and identifying the most effective intervention components are challenges for future research.

Keywords: binge drinking; narrative review; health consequences; interventions

Definitions of binge drinking

Binge drinking is one of the most important concepts used in alcohol epidemiology to determine the burden resulting from alcohol use (World Health Organization, 2014). Interest in binge drinking has increased in recent decades, leading to a growing body of published scientific research. A preliminary PubMed search with the keywords ‘(binge or risky single occasion or heavy episodic or intoxication or drunkenness or inebriation)’
and alcohol and drinking’ revealed that 3029 papers had been published on the subject in the last five years (from 1 August 2011 to 31 July 2016); 2988 in the 10 years before that (from 1 August 2001 to 31 July 2011); 2191 in the 20 years before that again (from 1 August 1981 to 31 July 2001).

In the 1990s, Wechsler and colleagues (Wechsler, Davenport, Dowdall, Moeykens, & Castillio, 1994; Wechsler & Isaac, 1992) introduced the term ‘binge drinking’ to describe a consumption pattern of a given amount of alcohol on a single occasion. The National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2004) approved this definition of binge drinking as ‘a pattern of drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 gram percent or above. For the typical adult, this pattern corresponds to consuming 5 or more drinks (male), or 4 or more drinks (female), in about 2 hours’.

Historically, the measure of 5 + can be traced to the beginning of survey research in the US back in the late 1960s (Cahalan & Room, 1974); then it was labelled ‘heavy intake’ (whereas the term ‘binge’ referred to heavy drinking over an extended period of several days).

Nowadays, the term is commonly used to describe the consumption of more than X number of drinks on one occasion. To confuse matters, other labels are also used in parallel to describe the same drinking pattern. These include heavy episodic drinking, risky single occasion drinking, heavy sessional drinking, heavy drinking and risk drinking (e.g. Dawson, Li, & Grant, 2008). Moreover, some researchers derived a binge drinking measure from standard quantity-frequency instruments that use quantities ‘typically’ or ‘usually’ consumed on a given occasion or day (e.g. Foster, Held, Gmel, & Mohler-Kuo, 2016; Lee, 2012). By doing so, binge drinking is assessed not as a single-occasion heavy intake but as the usual high quantity when drinking.

Binge drinking, according to the contemporary definition, is commonly measured by asking about the frequency of consumption that exceeds a given amount at a given moment, e.g. ‘How often in the past 12 months (or 30 days) have you had X drinks or more on a single occasion?’ For comparative purposes across different studies and subsamples, a single item measure of binge drinking like this one comes with a number of caveats.

First, it inherently needs a definition of a standard drink. What this implies is that with the same number of X drinks, someone who predominantly drinks beer will ingest about the same amount of pure ethanol as a person who predominantly drinks wine or spirits. This may be a relatively easy task in some countries where serving sizes have roughly the same amount of pure ethanol (though this may be questionable for drinks poured at home). However, problems could arise when carrying out surveys in those countries where serving sizes differ in terms of their pure ethanol content. For example, in Switzerland a common serving size for beer is 3 dl. This contains about 12 g of pure ethanol (with an assumed alcohol by volume [ABV] of 5%). However, wine often comes in 1 dl servings, which is less than 9 g of pure ethanol for white wine (with an ABV of 11%), and more than 11 g for red (with an ABV of 14%). Spirits are commonly served as 2 cl, which contains 6.4 g of pure ethanol (ABV of 40%).

Second, it is intuitively clear that the prevalence of binge drinkers, as well as the potential effects of binge drinking, depend on the cut-off used for X drinks. There will be fewer binge drinkers with a cut-off of, say, 10 drinks than with a cut-off of 5 drinks, and the intoxication level will also vary. Of course, differences in measures make
comparisons over time difficult, even within the same country. For example, in the UK the cut-off was commonly defined as 11 + units on one occasion (Gmel, Rehm, & Kuntsche, 2003). Yet, at the same time other measures were used, such as 8+/6+ (men/women) or 10 + for men and 7 + for women. These measures represented half of the recommended maximum intake of alcohol per week.

Third, cross-country comparisons in fact tend not to be comparable even when they use the same cut-off for the number of drinks. This is owing to a large variation in what constitutes ‘a drink’ or a ‘unit’ in terms of pure ethanol. For example, in the UK a unit is defined as 8 g of pure ethanol, whereas in the US a drink was considered to contain 12 or 14 g (World Health Organization, 2000). Hence, using the same 5 + measure, an intake of as little as 40 g of pure ethanol, or as much as 70 g, can qualify as a binge. Additionally, the prevalence and composition of binge drinkers will differ depending on the recall period of 12 months, 30 days, or 7 days. A 12-month recall will include individuals who have rare or infrequent binge drinking episodes, whereas a 7-day recall will likely include only more regular binge drinkers. Additionally, the definition of what is an ‘occasion’ (drinking in a row, in one sitting, within 2 h, within one day) will impact on the composition of binge drinkers in a sample and distort the comparability across studies. For example, in the US (Kerr, Greenfield, Bond, Ye, & Rehm, 2009) binge drinking frequency is often defined as five or more drinks ‘on a day’, assuming that there is usually only one binge drinking occasion within a day (e.g. in the evening). However, consuming five or more drinks a day tends to have a different meaning when, for example, alcohol is consumed twice a day with meals. The effects of having five or more drinks spread over lunch and suppertime is likely to be completely different from those resulting from the consumption of the same amount of alcohol within 2 h in a bar setting (Kuntsche, Plant, Plant, Miller, & Gmel, 2008).

Until the work of Wechsler et al. (1994), binge drinking was measured identically for both men and women, i.e. the consumption of five or more drinks. To achieve a similar BAC, men tend to have to drink more than women. Consequently, the 4 + -measure was introduced to account for the different body constitution and alcohol metabolism of women. Wechsler et al. (1994) showed that women experienced, with about the same likelihood, alcohol-related consequences after 4 drinks as men did after 5 drinks. Also, Lange and Vos (2001) showed that men need about 1.5 drinks more than women to reach a BAC of about 0.08%. The use of gender-specific measures (4+/5+, 6+/8+, 7+/10+) has since become the norm.

Interestingly, the most widely used screening instrument for problematic alcohol use, the Alcohol Use Disorder Identification Test (AUDIT: Babor, Higgins-Biddle, Saunders, & Monteiro, 2001), does not differentiate between the amount consumed by men and women on a binge, despite some evidence that a lower threshold for women may increase the sensitivity and specificity of the test (see e.g. Olthuis, Zamboanga, Ham, & Van Tyne, 2011; Reinert & Allen, 2002). Recently, drinking guidelines in Australia (National Health and Medical Research Council, 2016) and the UK (Department of Health, 2016) and STEPwise approach to Surveillance (World Health Organization, 2016), for example, use the same quantities for both sexes. One reason may be that women may experience fewer consequences, particularly the acute variety (e.g. traffic casualties and injuries), than men even at the same BAC level because they are less impulsive and risk-seeking, or because they take more precautions against the negative effects of their drinking.
Health impact of binge drinking

**Acute consequences of even a single binge to the drinker**

Binge drinking among adolescents and young adults commonly occurs on weekends, with moderate or no drinking on most other weekdays (Kuntsche & Gmel, 2013). This drinking pattern is widely associated with an increased risk of acute consequences, including long-lasting effects, e.g. irreversible disabilities due to injury or death (Anderson, 2007; Courtney & Polich, 2009; Dawson et al., 2008; Gmel et al., 2003; Ham & Hope, 2003; Plant & Plant, 2006). This also includes consequences directly related to the state of intoxication, such as hangovers, blackouts, memory loss, nausea and vomiting. High doses can lead to alcohol poisoning, with occasional fatalities. Among young people, binge drinking is associated with academic or educational impairment owing to missed classes, falling behind on work and lower grades. These consequences become more pronounced as the frequency of binge drinking increases.

Binge drinking may also lead to unintended and unprotected sexual activity (Perkins, 2002). A recent systematic review and meta-analysis showed that the intention to engage in unprotected sex increased by about 5% with a 0.1 g/ml rise in BAC (Rehm, Shield, Joharchi, & Shuper, 2012). Thus, binge drinking may be an important factor in the transmission of HIV and other sexually transmitted diseases. During college years about 20% of women in the US were victims of rape or other sexual assaults; these were often related to binge drinking on the part of the victim and/or the perpetrator (Abbey, 2002; Krebs, Lindquist, Warner, Fisher, & Martin, 2009; Mohler-Kuo, Dowdall, Koss, & Wechsler, 2004; Testa, VanZile-Tamsen, Livingston, & Koss, 2004).

Due to its cognitive and psychomotor effects on reaction time, cognitive processing, and coordination (Gmel et al., 2003), alcohol use is a major contributory factor in the incidence of injuries, motor vehicle accidents and other trauma, particularly among younger age groups. For alcohol-related injuries, binge drinking has been found to be a major factor (Taylor, Shield, & Rehm, 2011). The literature on injury risks associated with binge drinking has found evidence predominantly in relation to drink-driving (Gruenewald, Mitchell, & Treno, 1996; Treno, Gruenewald, & Ponicki, 1997). For example, the reanalysis of the Grand Rapids Study (Hurst, Harte, & Frith, 1994) found that the risk of motor vehicle accidents increased exponentially with rising BAC levels, and that these increases were steeper for those who usually have low drinking frequencies. This may be a result of two factors that unfortunately cluster among young people, namely a lower tolerance of the effects of alcohol among less experienced drinkers, and little driving experience. Using emergency department data, Gmel, Kuntsche, and Rehm (2011) showed that this particular effect of binge drinking (intermittent heavy drinking occasions with otherwise low alcohol consumption) also applies to injuries in general. The study, which differentiated between the volume of drinking and binge drinking, found that those who normally drank lightly (but did have binge drinking episodes) were at higher risk than chronic heavy drinkers, despite ingesting approximately the same volume of alcohol in the 6 h before the injuries occurred.

Binge drinking is not only a risk factor for unintentional injuries (Hingson & Zha, 2009), but also for intentional injuries such as violence and homicide (Brewer & Swahn, 2005), as well as self-inflicted harm and suicide (Borges & Loera, 2010; Norstrom & Rossow, 2016; Schaffer, Jeglic, & Stanley, 2008). However, causality
remains unclear, i.e. whether high doses of alcohol are used prior to the planned suicide to ease expected pain, for example, or to self-medicate alcohol-induced depression as a main factor following suicide attempts.

Overall, it has been estimated that acute conditions, which are often related to binge drinking, may be responsible for over 50% of the alcohol-related deaths with an even higher proportion for years of life lost (Centers for Disease Control and Prevention, 2004). However, using acute conditions as a proxy for the binge drinking-related burden probably overestimates the effects of binge drinkers whose alcohol consumption is otherwise moderate. This is because these effects are commonly not separated from the burden borne by heavy chronic drinkers, whose (almost) daily drinking pattern involves the ingestion of alcohol quantities that qualify as binge drinking. However, such estimates of burden tend not to include the harm of binge drinking to third parties.

Harm to others from binge drinkers

The harm to others (e.g. Laslett et al., 2011) through binge drinking may be relatively minor, such as being wakened by the noise of a drunken passer-by, but they can also be very severe, including death or a lifelong physical and mental disability, e.g. involvement in a car crash by an intoxicated driver. Binge drinking may harm others through fights and interpersonal violence (Perkins, 2002) resulting from the disinhibiting effects of alcohol; these appear even more influential than the intoxication effect itself (Miller et al., 2016). Also, the expectation that intoxication can be used as a pretext to avoid or reduce social censure and other consequences at a later point in time (McMurran, 2012) may influence the decision to use force instead of avoiding conflict. The effects of alcohol on attention, cognitive processing, and impulse control may also lead to the misinterpretation of cues from others, e.g. wrongly interpreting the behaviours of others as aggressive (Giancola, Josephs, Parrott, & Duke, 2010; Townshend, Kambouropoulos, Griffin, Hunt, & Milani, 2014). The misinterpretation of women’s sexual intentions may be a factor in sexual violence and rape perpetrated predominantly by males (Abbey, McAuslan, & Ross, 1998) who had been binge drinking. Frequent binge drinking episodes or the intake of particularly high volumes of alcohol may also have severe long-term consequences for the unborn (Gmel et al., 2011). Binge drinking may result in an economic burden for others through property damage and vandalism, and last but not least for society as a whole because of the social and economic costs incurred by the health-care and justice sector (e.g. law enforcement costs including costs of policing, court costs and costs of incarceration), and productivity losses (Rehm et al., 2009; World Health Organization, 2014).

Binge drinking as a pathway to long-term heavy drinking and related consequences

Despite the many findings that early (adolescent) binge drinking was associated with long-term consequences including alcohol use disorders (Chassin, Pitts, & Prost, 2002; Dawson et al., 2008; Hill, White, Chung, Hawkins, & Catalano, 2000; Viner & Taylor, 2007; Zucker et al., 2006), it still remains unclear whether these long-term chronic consequences were actually the effects of binge drinking per se, or whether they mainly reflected (a) usual heavy drinking (for which binge drinking is a regular, often daily, pattern); (b) a broader ‘problem behaviour syndrome’, also associated with general
problems, i.e. a family history of alcohol use disorder; or (c) comorbidities such as antisocial personality disorder and delinquency, where early onset of binge drinking, although clearly related to adverse consequences (Hingson & Zha, 2009; Rossow & Kuntsche, 2013), is sometimes only one of many symptoms, and not the main or single cause of chronic consequences (Gmel et al., 2011; Rossow & Kuntsche, 2013).

However, recent neuroimaging studies using event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI) have found that repeated binge drinking among adolescents and young adults is associated with neurophysiological impairments and with abnormal activities in occipital, hippocampal, frontal and prefrontal areas (for reviews of the literature, see Courtney & Polich, 2009, 2010; Maurage et al., 2012; Petit, Kornreich, Verbanck, & Campanella, 2013; Petit, Maurage, Kornreich, Verbanck, & Campanella, 2014). In some studies this was also found when controlling for family history of alcohol misuse, psychiatric comorbidities, or effects due to the use of other substances like cannabis (Courtney & Polich, 2010; Maurage et al., 2012; Townshend et al., 2014). It appears that adolescence is a critical period for brain development. It is during these extensive neuromaturational processes that significant restructuring of the brain takes place. Consequently, the adolescent brain is particularly sensitive to alcohol, and binge drinking may therefore result in long-term changes in general brain functioning.

Moreover, some studies investigated the typical pattern of binge drinking with heavy alcohol intake during certain episodes (weekend) coupled with abstinence or low consumption on most other days, and compared individuals with a binge pattern to those with the same overall alcohol intake, but who drank more frequently and did not binge. These studies suggest that the specific consumption pattern of alternating alcohol intoxications and abstinent episodes, which is linked to excitotoxic cell death during withdrawal, may be particularly deleterious for the brain (e.g. Maurage et al., 2012; Petit et al., 2014).

Most of the brain deficits among adolescent and young adult binge drinkers mirror those observed in chronic alcohol dependents, although they tend to be less marked. This strengthens the ‘continuum hypothesis’ which posits that binge drinking and alcohol dependence may reflect two stages of the same phenomenon, leading to parallel brain deficits (e.g. Courtney & Polich, 2010). Repeated binge-induced neuroadaptations in incentive motivation and reward systems may cause hypersensitivity to alcohol-related stimuli (cue reactivity), which in turn could prevent binge drinkers from maturing out. As a consequence, heavy drinking patterns could persist and ultimately lead to alcohol dependence (Petit et al., 2013). In addition, young binge drinkers have been shown to be more sensitive to euphoric positive effects during the rise of the blood alcohol concentration, but less sensitive to the sedative negative effects during the increasing and declining phase. This differential sensitivity to the biphasic response (e.g. reduction in or absence of negative effects) found in frontal lobe processing may also contribute to the maintenance of ‘bad’ drinking patterns, thereby leading to heavy, problematic or dependent drinking in adulthood (Courtney & Polich, 2009). As stated by Petit et al. (2014), binge drinking is not just inoffensive social fun, but if carried on, may contribute to the onset of cerebral disturbances leading to alcohol dependence later in life. Binge drinking, therefore, may be associated with all of the long-term consequences seen in heavy chronic or even dependent drinkers.
Prevalence of binge drinking

As explained above, prevalence rates vary widely across countries, but it is often difficult to separate cultural variations from variations due to different measurements, time frames and restriction of age groups etc. For example among 18–29 year olds in Ireland, Mohamed and Aimal (2015) estimated that 73% of men and 53% of women have had at least one binge drinking occasion in the past year, whereas among 15–64 year olds in Spain 10% of men and 4% of women had at least one binge drinking occasion in the past 30 days with a binge occasion being defined by consuming 80 g of pure ethanol for men and 60 g for women (Soler-Vila et al., 2014). It is intuitively clear that such data from surveys are difficult to compare. In an attempt to harmonise estimates of binge drinking (60 g on an occasion at least once in the past 30 days) worldwide for the population of 15 years and older, it was estimated that 7.5% binge drink at least weekly (World Health Organization, 2014). However, this proportion varies widely across regions with only 0.1% in the Eastern Mediterranean Region containing mainly Islamic states and 1.6% in the South-East Asian Region (mainly India) to 13.7% in the American region and 16.5% in Europe. The prevalence of binge drinking strongly depends on the number of abstainers. Among drinkers prevalence rates of bingers is 16% worldwide.

Among young people, the European School Survey Project on Alcohol and Drugs (ESPAD, The ESPAD Group, 2016) provide comparable data on binge drinking of five drinks on an occasion. For 2015 it was estimated that about 35% of 15–16 year olds have had at least one binge drinking occasion in the past 30 days. These prevalence rates in Europe ranged from 8% in Iceland and 11% in the US to 56% in Denmark.

Despite narrowing gender differences in the last two decades (Keyes, Li, & Hasin, 2011; Kuntsche et al., 2011), there is robust evidence that binge drinking is more common among men than women (Kuntsche & Gmel, 2013; Kuntsche, Rehm, & Gmel, 2004). This is generally true for the adult population in almost all countries (World Health Organization, 2014). The largest gender differences can be found in the WHO South East Asia Region and in the West Pacific Region where the binge drinking rates of men are almost 11 times (India) and over 7 times (China) higher than among women. In the European Region and the American Region the rates are 2.5 times higher for men than for women. This is not the case among 15–16-year-olds, at least in Europe. In 2015, binge drinking prevalence in the last 30 days was basically the same among boys (13%) and girls (12%) with some countries such as Malta, the Netherlands and Sweden showing even higher prevalence rates for girls than for boys in this age group (The ESPAD Group, 2016).

In the majority of established market economies, at least in those for which most of the published literature comes from, i.e. North America and Europe, prevalence of binge drinking increases sharply in adolescence and peaks in early adulthood (around the age of 20–25) (Kuntsche & Gmel, 2013). Subsequently, prevalence rates decrease with age, most likely due to maturing out and the adoption of adult roles. It should be noted, however, that the dominance of binge drinking in adolescence and early adulthood is not a worldwide phenomenon. In the WHO South-East Asian Region (including India), binge drinking is more prevalent among older age groups than among adolescents (15–19 year olds); in the Africa region, the prevalence of binge drinking among the adolescent and older populations is at a similar level (World Health Organization, 2014).
The majority of studies have found the higher the level of parental education, the higher their offspring’s binge drinking frequency (Abebe, Hafstad, Brunborg, Kumar, & Lien, 2015; Charitonidi et al., 2016; Kendler et al., 2014; Pedersen & von Soest, 2013; Sajber, Tahiraj, Zenic, Peric, & Sekulic, 2016; Stafstrom, 2014; Steiner, Schori, & Gmel, 2014). It is possible that these parents monitor their children’s activities less closely due to high job demands. However, some studies found no (Sweeting & Hunt, 2015; Zarzar et al., 2012) or an inverse link (Melotti et al., 2013; Pedersen & von Soest, 2013; Tucker, Pollard, de la Haye, Kennedy, & Green, 2013). The evidence is even less clear concerning greater family affluence and higher socio-economic status. Some studies found a link to frequent adolescent binge drinking (Elisaus et al., 2015; Huang, Ho, Wang, Lo, & Lam, 2016; Kendler et al., 2014; Melotti et al., 2013), while others did not (Steiner et al., 2014; Tucker et al., 2013), or found an inverse link (Legleye et al., 2013). Kwok and Yuan (2016) conclude from their recent literature review that in developing countries where parents tend to be poorer and less educated families show more binge drinking whereas in developed countries the frequency of adolescent binge drinking depends more on the specific behaviours of parents and friends (see below).

In the US, there is ample evidence that binge drinking rates are higher among college students than among non-college age-mates (Barnes, Welte, Hoffman, & Tidwell, 2010; Dawson, Grant, Stinson, & Chou, 2004; Patrick & Terry-McElrath, 2017). After high school, students who go to college increase their binge drinking distinctly more and actually surpass their nonstudent age-mates (O’Malley & Johnston, 2002; Timberlake et al., 2007). This is most likely due to the combination of approaching the legal drinking age (21 in the US), leaving home (and parental supervision), and being together with peers most of the day, often in societies instigating drinking (fraternities, sororities, sport teams etc.). Although college students outside the US have also high binge drinking rates (Karam, Kypri, & Salamoun, 2007; Wicki, Kuntsche, & Gmel, 2010), it is unclear whether these rates are significantly higher than those of their non-college age-mates due to a lack of direct comparisons. However, the impact of college attendance on binge drinking is also likely to vary in function of demographic, personality (including sensation-seeking and impulsivity) and environmental characteristics (such as college location and size and alcohol outlet density, Carter, Brandon, & Goldman, 2010; Quinn & Fromme, 2011). For example, college attendance increases the likelihood of binge drinking among whites whereas the opposite is the case among blacks and Asians (Paschall, Bersamin, & Flewelling, 2005).

Correlates and determinants of binge drinking

**Person-specific factors (I): personality, impulsivity, attentional bias**

Concerning the ‘Big Five’ personality traits, there is consistent evidence that binge drinking is more common among those who score highly on extroversion, but low on agreeableness, conscientiousness, openness, and neuroticism (Cheng & Furnham, 2013; Ibanez et al., 2015; Zhang, Bray, Zhang, & Lanza, 2015). However, when a recent large-scale study in Britain accounted for other factors, such as gender, intelligence and socio-economic status, only extroversion and agreeableness remained significant predictors (Cheng & Furnham, 2013). The authors argued that extroverts tend to be more
impulsive and engage more often in social activities which involve alcohol. They also posited that those low in agreeableness (low on modesty, generosity, compliance, sympathy, and consideration for others) may find it easier to ignore behavioural norms (Cheng & Furnham, 2013).

A link has also consistently been found between binge drinking and personality traits like impulsivity, disinhibition and sensation/novelty-seeking (Carlson & Johnson, 2012; Czapla et al., 2015; Kuntsche et al., 2004; Park, Kim, Gellig, Zaso, & Maisto, 2014; Shin, Hong, & Jeon, 2012; Wellman, Contreras, Dugas, O’Loughlin, & O’Loughlin, 2014). A recent meta-analysis even found that among different impulsivity-related personality traits (lack of premeditation, lack of perseverance, sensation-seeking, negative urgency, positive urgency, and reward sensitivity) which were positively associated with binge drinking, sensation-seeking had the strongest association across studies (Stautz & Cooper, 2013). One explanation is that young people, particularly men, who have an impulsive, risk-seeking personality, like and actively seek extreme sensations, such as the feeling of drunkenness (Balodis, Potenza, & Olmstead, 2009; Kuntsche, Knibbe, Gmel, & Engels, 2006b). Binge drinking therefore is a particularly rewarding behaviour for them (Park et al., 2014).

Repeated alcohol intoxication also increases sensitisation to alcohol-related cues owing to an increased attention bias or priming (Field & Cox, 2008; Field, Wiers, Christiansen, Fillmore, & Verster, 2010; Hicks, Fields, Davis, & Gable, 2015). In addition, binge drinking reduces the capacity for self-regulation or inhibitory control, i.e. controlling impulses and resisting urges to drink (Neal & Carey, 2007; Robinson, Jones, Christiansen, & Field, 2015; Townshend et al., 2014; Van der Veen, Cohen, & Watson, 2013; Weafer & Fillmore, 2008, 2013). A recent study found that alcohol-related cues impair inhibitory control even among young adults who usually drink but who were currently sober; this effect was exacerbated when under the influence of alcohol (Weafer & Fillmore, 2015). It would therefore appear that binge drinkers are likely to start drinking due to an automatic appetitive response to alcohol-related cues. Once triggered, these cues become more salient, and acute alcohol-induced disinhibition leads to binge drinking at that given moment because it impairs the ability of the drinker to stop or control further alcohol intake.

**Person-specific factors (II): negative experiences and emotions**

Besides positive reinforcement (i.e. binge drinking as a means of sensation-seeking), binge drinking can be used for negative reinforcement, i.e. to alleviate or forget about problems and worries. Consequently, a variety of studies has provided evidence that experiencing stress, anxiety, traumatic events and depressive episodes are related to binge drinking in general, especially among females (Choi & Dinitto, 2011a, 2011b; Kachadourian, Pilver, & Potenza, 2014; Mushquash, Sherry, Mackinnon, Mushquash, & Stewart, 2014; Prado Jde, Kerr-Correa, Lima, da Silva, & Santos, 2012; Skinner, Kristman-Valente, & Herrenkohl, 2016; Timko, Sutkowi, Pavao, & Kimerling, 2008; Wellman et al., 2014). However, in the case of depression, this link was not always significant (Choi & Dinitto, 2011a, 2011b; Gonzalez, Reynolds, & Skewes, 2011; Prado Jde et al., 2012); in certain cases it was even non-existent (Harrell & Karim, 2008).

Self-medication can be a reason for binge drinking, i.e. the consumption of large amounts of alcohol at a given moment to alleviate, cope with or feel better after
negative events or emotions (Kuntsche & Bruno, 2015; Mushquash et al., 2014; Stewart & Conrod, 2008). However, there is also evidence for a reversed causation, i.e. that binge drinking is responsible for depressive symptoms over time (Paljarvi et al., 2009). Binge drinking can also lead to traumatic experiences such as being the victim of physical and/or sexual assault or a severe accident (Kachadourian et al., 2014), as well as other assorted negative consequences (see above).

Using binge drinking to cope with problems, depressive symptoms and negative experiences or emotions often creates a vicious circle, in which both aspects feed off each other because the deficits in problem-focused coping have not been adequately addressed (Kuntsche, Knibbe, Gmel, & Engels, 2006a; Stewart & Conrod, 2008). Likewise, abstaining from alcohol when being confronted with adversities can protect individuals from binge drinking. Feeling sad, hopeless or worthless curtails outgoing behaviour and participation in social relationships or events (e.g. parties and celebrations) during which context binge drinking usually occurs. It may also prompt the person to seek help or professional support to enable them to cope better with stress, depression or negative events (Wellman et al., 2014). One study found that among those who scored low on coping motives for drinking, the higher their anxious or depressed mood was, the lower their alcohol consumption on a given day; this was not the case for those scoring high on coping motives for drinking (Grant, Stewart, & Mohr, 2009). It appears that when facing depression or anxiety, only those who drink in an attempt to alleviate these negative emotional states (coping drinkers) are at risk for binge drinking and, as such, do not seek help or reduce drinking-related social activities. Thus, finding a significant link between depression and binge drinking is likely to depend on factors such as drinking motives and this may be responsible for the inconsistent findings described above.

**Person-specific factors (III): motives, expectancies**

There is consistent evidence across studies that the higher participants score on enhancement motives (defined as drinking to increase positive affect internally, e.g. drinking to have fun), the higher their binge drinking frequency (Cooper, Kuntsche, Levitt, Barber, & Wolf, 2016; Kuntsche, Stewart, & Cooper, 2008). The same was found for coping motives (drinking to reduce negative affect internally, e.g. drinking to forget about problems), although to a lesser degree (about half the effect size). For social motives (drinking to increase positive affect externally, e.g. to celebrate with friends) and for conformity motives (drinking to decrease negative affect externally, e.g. to fit in or avoid peer rejection), there was no consistent association. It appears that enhancement and coping drinkers need to consume a large volume of alcohol per occasion to feel the psychoactive effects and to forget about their problems. In contrast, only one or two drinks per occasion are principally enough to achieve the goal of celebrating (social motives) or fitting in with peers (conformity motives).

Enhancement-motivated drinkers were also found to score high on sensation-seeking and extroversion, and coping drinkers on neuroticism and depression (Cooper et al., 2016; Kuntsche et al., 2006b). There is even strong evidence that the effect of these personality traits on binge drinking frequency is mediated through high levels of enhancement and coping motives (Adams, Kaiser, Lynam, Charnigo, & Milich, 2012; Kuntsche, von Fischer, & Gmel, 2008; Lammers, Kuntsche, Engels, Wiers, & Kleinjan,
A recent study concluded that aspects such as motivations and norms (see below) are more important predictors of drinking patterns, including binge drinking, than personality factors (Lac & Donaldson, 2016). Binge drinking among enhancement- and coping-motivated drinkers appears to be particularly common among older adolescents and young adults in North America and in some European countries like Switzerland. Among younger adolescents (Kuntsche & Müller, 2012; Kuntsche et al., 2014), or in countries such as Brazil, Hungary, the Netherlands and Spain (Hauck-Filho, Teixeira, & Cooper, 2012; Németh, Kuntsche, Urbán, Farkas, & Demetrovics, 2011; Schelleman-Offermans, Kuntsche, & Knibbe, 2011), social motives played a more prominent role in explaining binge drinking frequency than coping motives, and were sometimes as closely related to binge drinking as enhancement motives. It appears that younger adolescents’ binge drinking occurs more often in conjunction with social factors and rewards than it does for older adolescents, who are more likely to drink to change internal emotional states (Kuntsche et al., 2014). Among young adults in Vietnam, the relationship between binge drinking and coping motives was much stronger than the relationship to enhancement and social motives (Diep, Schelleman-Offermans, Kuntsche, De Vries, & Knibbe, 2016).

Like personality traits, there is consistent evidence that drinking motives mediate the link between alcohol expectancies and binge drinking frequency (Diep et al., 2016; Kuntsche, Knibbe, Gmel, & Engels, 2007; Kuntsche, Wiers, Janssen, & Gmel, 2010). This would suggest that drinking motives constitute a final common pathway to binge drinking, i.e. the gateway through which a variety of more distal influences are mediated (Cooper et al., 2016).

Social factors (I): parents

Parents are the primary socialisation agency and also function as role models for normative behaviour. A variety of studies provide evidence of the correspondence between the binge drinking behaviour of parents and their adolescent offspring (Abar, Turrisi, & Mallett, 2014; Cleveland, Reavy, Mallett, Turrisi, & White, 2014; Crutzen, Giabbanelli, Jander, Mercken, & de Vries, 2015; Donaldson, Handren, & Crano, 2016; Haugland, Strandheim, & Bratberg, 2012; Klima, Skinner, Haggerty, Crutchfield, & Catalano, 2014; Pedersen & von Soest, 2013). Besides shared genetic factors that may be partly responsible for this link (Crabbe, Harris, & Koob, 2011; Desrivieres et al., 2008), role modelling and social learning processes are important because adolescents may adopt the excessive substance use habits of parents and siblings even if they perceive the negative consequences of it and judge it as ‘too high’ (Kuntsche & Meyer, 2002). However, the strength of the role modelling effect was found to be stronger for young people growing up with a binge drinking father than with a binge drinking mother, and stronger for boys than for girls (Crutzen et al., 2015). The authors concluded that fathers are more visible role models and thus more important for binge drinking modelling than mothers. In addition to direct modelling, parental binge drinking can establish or contribute to the impression that this behaviour is normal (descriptive norms) or approved (injunctive norm). Adolescents may interpret seeing parents drink to intoxication as a sign that binge drinking is acceptable and a normal drinking pattern (Haugland et al., 2012; Pape, Rossow, & Storvoll, 2015; Pedersen & von Soest, 2013).
Whereas adolescents’ binge drinking is unlikely to occur when drinking at home under the supervision, or in the company of their parents, there is consistent and strong evidence that parental behaviours, such as permission to drink at home or drinking together, are risk factors for adolescent binge drinking (Kaynak, Winters, Cacciola, Kirby, & Arria, 2014; Pape et al., 2015; van der Vorst, Engels, & Burk, 2010); though this usually occurs outside the home. Interestingly, parental supply of alcohol was not consistently associated with adolescent binge drinking (Kaynak et al., 2014). Dietze and Livingston (2010) found that the likelihood of binge drinking was lower when the alcohol was provided by parents than by other sources. In contrast, procuring alcohol from both parental and other sources was associated with the highest binge drinking likelihood. There is consistent evidence that stricter parental rules on drinking or stronger parental disapproval of underage drinking was associated with a lower frequency of adolescent binge drinking (Abar et al., 2014; Fairlie, Wood, & Laird, 2012; Harakeh, de Looze, Schrijvers, van Dorsselaer, & Vollebergh, 2012; Pape et al., 2015). This was even the case when controlling for peer influences (Martino, Ellickson, & McCaffrey, 2009; Schwinn & Schinke, 2014). Among young adults, however, the perceived approval of alcohol use by friends fully mediated the relationship between perceived parental approval and binge drinking: those who believed their parents approved of drinking tended to believe that their friends also approved, which in turn was associated with their binge drinking (Rulison, Wahesh, Wyrick, & DeJong, 2016).

Besides the alcohol-related behaviours of parents, general parenting features — parenting styles, monitoring, emotional support and consistent discipline — are important. There is consistent evidence that adolescents whose parents provide both boundaries and empathy, and monitor their activities and whereabouts have a lower binge drinking risk (Donaldson et al., 2016; Kelly et al., 2016; Klima et al., 2014; Pedersen & von Soest, 2013; Soloski, Kale Monk, & Durtschi, 2016; Song, Smiler, Wagoner, & Wolfson, 2012; Steiner et al., 2014; Stickley et al., 2013). In contrast, authoritarian or neglectful parents are more likely to have binge drinking offspring (Stafstrom, 2014). The impact of older siblings’ binge drinking on younger siblings’ binge drinking was also found to be higher in dysfunctional families than among those with a good parent–child relationship and close parental monitoring (Gossrau-Breen, Kuntsche, & Gmel, 2010; Richmond-Rakerd, Slutske, Heath, & Martin, 2013). Aspects of general parenting appear to be more important in adolescence than in young adulthood, although one study found that parental monitoring had no impact on the child’s binge drinking (Fairlie et al., 2012).

In terms of family structure, the evidence is inconsistent as to whether or not living in a single-parent family is a risk factor for binge drinking (Harakeh et al., 2012; Pedersen & von Soest, 2013; Song et al., 2012; Steiner et al., 2014). This may depend on third variables, such as parent–child communication and a good parent–child relationship (Kuntsche & Silbereisen, 2004; Tomcikova, Veselska, Geckova, van Dijk, & Reijneveld, 2015). If the single parent enjoys a good relationship and open communication with her or his child, the binge drinking risk of the latter is no higher than that of a child living in a two-parent family.

Social factors (II): peers

Peers become more and more influential as adolescents grow older. Consequently, a variety of recently published studies have demonstrated that frequently spending time
with friends, having friends who drink, or drinking with friends is a major risk factor for binge drinking (Dietze, Livingston, Callinan, & Room, 2014; Eisenberg, Golberstein, & Whitlock, 2014; Elisaus et al., 2015; Hahm, Kolaczyk, Jang, Swenson, & Bhindarwala, 2012; Harakeh et al., 2012; He, Assanangkornchai, Cai, & McNeil, 2016; Kelly et al., 2016; Kuntsche, Kuendig, & Gmel, 2008; Kuntsche, Otten, & Labhart, 2015; Mustonen, Makela, & Lintonen, 2016; Scholly, Katz, & Kehl, 2014; Seid, Hesse, & Bloomfield, 2016; Simons-Morton et al., 2016; Soloski et al., 2016; Song et al., 2012; Stickley et al., 2013; Tomczyk, Isensee, & Hanewinkel, 2015; Washburn, Capaldi, Kim, & Feingold, 2014).

Peers can directly influence the binge drinking behaviour of an individual, e.g. by offering drinks (Schwinn & Schinke, 2014). They can also exert an indirect influence through role modelling and perceived norms. Binge drinkers tend to have a higher social status within their peer group than those who drink less (Dumas, Graham, Bernard, & Wells, 2014; Dumas, Wells, Flynn, Lange, & Graham, 2014; Hahm et al., 2012), hence a greater likelihood that others will model this behaviour. Similar to the parental factors described above, perceived norms and approval of friends were closely linked to own binge drinking (Fairlie et al., 2012; Lac & Donaldson, 2016; Rulison et al., 2016). In a cross-national study, binge drinking was also rated as being most acceptable in situations involving friends (Fjær, Pedersen, von Soest, & Gray, 2016). Moreover, social norms from multiple sources (parents, friends and schools) are likely to interact with each other – apparently creating an overall impression of normality and acceptability of alcohol use – and were found to predict adolescent binge drinking over time (Lynch, Coley, Sims, Lombardi, & Mahalik, 2015).

Other prominent explanations concern the selection and socialisation effects of peers. A recent review of longitudinal evidence (Leung, Toubbourou, & Hemphill, 2014) found that exposure to peer alcohol use (socialisation) maintained a significant predictive effect on own alcohol use (including binge drinking) after adjusting for prior alcohol use (selection). In a recent study, however, the impact of peers on own binge drinking was found only among those who had a history of alcohol use (Guo, Li, Owen, Wang, & Duncan, 2015). This favours the selection hypothesis more than the socialisation/influence hypothesis. Most likely, both processes are happening, i.e. when adolescents look for new friends (e.g. when changing school or moving to another town), they tend to select those who have similar substance use habits to their own, and being together with those friends will further boost or trigger their substance use (Urberg, Luo, Pilgrim, & Degirmencioğlu, 2003).

Besides the general link between alcohol-using peers and individual binge drinking, a series of moderators were identified. For example, similar to the child–parent relationship, the impact of friends on own binge drinking over time was moderated by friendship quality, i.e. the closer the relationship the higher the impact (Guo et al., 2015; Hiatt, Laursen, Stattin, & Kerr, 2015; Leung et al., 2014). Like the sibling effect, peer influence was found to be stronger among adolescents from dysfunctional families than among those with a good parent–child relationship and close parental monitoring (Leung et al., 2014). As observed for personality factors, one study found that the association between perceived peer drinking and young adult binge drinking was stronger among those with low self-control than among those with high self-control (Robinson et al., 2015).
Social factors (III): the wider social environment

Like the drinking norms observed within the family or in the peer group, the (perceived) prevalence of alcohol use or binge drinking at school or university was found to be associated with respondents’ binge drinking (Eisenberg et al., 2014; Kristjansson, Sigfusdottir, & Allegrante, 2013; Van Damme et al., 2016). In contrast, the better the climate at school or at class level (defined as high quality student-student and student-teacher relationships) the lower the binge drinking frequency (Ryabov, 2015; Tomeczyk et al., 2015). Moreover, a high prevalence of drinkers in the community, neighbourhood norms that were more accepting of binge drinking, or seeing others drinking in public were associated with individual binge drinking (Chauhan, Ahern, Galea, & Keyes, 2016; Kuntsche et al., 2008; Song et al., 2012). Similar to the effects of high family affluence and socio-economic status, frequent adolescent binge drinking was found in affluent neighbourhoods even when adjusted for individual characteristics (Kuipers et al., 2013; Pedersen, Bakken, & von Soest, 2015).

In addition, the virtual environment can contribute to alcohol-specific norms. There is recent evidence that the likelihood of participants’ binge drinking substantially increased with exposure to pro-alcohol content in Tweets or on Facebook (Cabrera-Nguyen, Cavazos-Rehg, Krauss, Bierut, & Moreno, 2016; D’Angelo, Kerr, & Moreno, 2014; Moreno, Cox, Young, & Haaland, 2015). The effects of social media on individual binge drinking were also found over time (D’Angelo et al., 2014). As is the case for peer selection and socialisation effects, the causal direction of this effect still needs to be clarified. For example, binge drinkers were found to display their alcohol-related behaviours on social media (Moreno, Christakis, Egan, Brockman, & Becker, 2012; Pumper & Moreno, 2013; Ridout, Campbell, & Ellis, 2012). Being exposed to such virtual pro-alcohol displays may further instigate alcohol consumption during drinking events (Whitehill, Pumper, & Moreno, 2015).

In addition to the social environment, there are cultural differences in binge drinking across countries. Despite the fact that adolescents from various European countries have become increasingly similar in terms of binge drinking in the last decades (Kuntsche et al., 2011), a recently published study found that within Europe, there are different country groupings. For example, the Netherlands, Germany, Denmark, Finland and Ireland belong to the group with a high binge drinking prevalence (Braker & Soellner, 2016). Also data from large cross-national projects like the Health Behaviour in School-Aged Children Study (Inchley et al., 2016) and the European School Survey Project on Alcohol and Drugs (Hibell et al., 2012) revealed large cultural differences with countries such as Armenia, Albania, Israel, Italy, Macedonia, and Portugal having a low proportion of binge drinkers and countries such as Bulgaria, Denmark, Estonia, Finland, Ireland, Slovak Republic and United Kingdom having a high proportion. The authors argued that excessive drinking on particular occasions is more socially acceptable in northern Europe than in the wine-producing countries of Southern Europe, where the predominant drinking pattern tends to be frequent consumption of moderate amounts of alcohol, often with meals (Braker & Soellner, 2016; Kuendig et al., 2008; Kuntsche et al., 2004; Room, 2001). Moreover, differences in alcohol policy and traditional drinking patterns in a society may also be partly responsible for cross-national differences in adolescent binge drinking (Bendtsen et al., 2014; Gilligan, Kuntsche, & Gmel, 2012). Interestingly, one recently published study found that cultural differences
in adolescent binge drinking were mediated by individual factors such as drinking motives (Kuntsche et al., 2015). The authors argued that not only do drinking motives represent the final decision to drink or not, and are therefore the most proximal factor for engaging in drinking, but they also tend to reflect or include more distal factors, such as culture (Cox & Klinger, 1988, 1990; Kuntsche et al., 2006a, 2006b).

**Interventions to change binge drinking**

When focusing on individual approaches, consideration must be given to at least three separate aspects: (1) the kind of intervention – from brief interventions (BI) of only a few minutes to group interventions with several sessions, boosters and motivation calls or structural measures; (2) the setting in which the programme is delivered – from highly specific settings such as an emergency department, parties or the workplace to more general prevention programmes focusing on entire populations; (3) the delivery mode, which in recent years has increasingly shifted from traditional face-to-face or postal mail to electronic delivery. In this section, we will set out the different types of binge drinking-related interventions, identify the target audience and setting of each intervention, and describe their mode of delivery.

**Individual interventions (I): types of interventions**

Brief interventions (BI) are used essentially in medical settings and aim to initiate changes in risky behaviour such as binge drinking. They are typically provided by trained staff and are targeted at drinkers who are non-dependent but whose alcohol consumption may cause harm to themselves and/or others. Once screened or assessed for problematic alcohol use, the individual usually receives feedback about their alcohol use and the associated risks and harm it can cause. Some interventions provide this feedback in the form of a comparison of the person’s drinking behaviour with that of similar individuals; this is known as ‘personalised normative feedback’. BI often involves motivational interviewing techniques, too (Miller & Rollnick, 2002). Motivational interviewing is a focused and goal-directed counselling style aimed at activating the intrinsic motivation of the drinker with a view to changing their drinking behaviour.

Universal prevention programmes, which are based on theoretical frameworks such as the social norms theory (Perkins, 2003), deploy a set of psychosocial approaches to prevent binge drinking. They often raise the individual’s awareness of high-consumption risks, provide strategies and skills to avoid risky drinking, and adjust misperceptions of social norms, motives and expectancies regarding alcohol use. The social norm theory posits that an individual’s behaviour is affected by their perception of how their peers think and are likely to act. Correspondingly, normative feedback approaches aim to change attitudes and norms towards drinking by raising awareness about alcohol use in a reference group and correcting misperceptions. These approaches have been successfully used in both universal and individual intervention efforts (Walters, 2000). Certain concepts applied in these prevention approaches overlap with the personalised normative feedback provided in BI. Although both are based on the same theory, the concepts behind them differ. Whereas the BIs described above are traditionally used to reduce the harm caused by existing alcohol misuse, personalised normative feedback
approaches aim to prevent intoxication and related harm, and take a normative, rather than person-centred, approach.

Another set of approaches are protective behavioural strategies (Pearson, 2013), i.e. behaviours that reduce the negative consequences of alcohol use (Martens, Pederson, LaBrie, Ferrier, & Cimini, 2007). These are also referred to as alcohol reduction strategies (Bonar et al., 2011), behavioural self-control strategies (Werch & Gorman, 1988) and drinking control strategies (Sugarman & Carey, 2007). Although these concepts vary somewhat in their operationalisation, all approaches commonly aim to limit the level of alcohol consumption through the setting of drinking limits. Skills’ training completes this concept by providing practical advice on how to consume alcohol in a safer way, e.g. learning to say no, avoiding heavy drinking or high-risk situations and refraining from excessive drinking.

Finally, approaches aimed at modifying positive alcohol outcome-related expectancies and/or drinking motives (Cox, Fadardi, & Klinger, 2006) are other psychosocial concepts used either to prevent binge drinking or as part of interventions in cases where the behaviour is already present. Given that positive alcohol expectancies predict higher alcohol use, and negative expectancies are associated with lower use (Jones, 2004; Leigh & Stacy, 2004), interventions have been devised to change these expectancies; they come in two forms. The first is based on experiential learning. This approach, usually in a group, provides alcohol or a placebo in a bar-like setting, and asks participants to socially interact. After a certain amount of time has elapsed, participants are then asked to evaluate whether the individuals to whom they had been talking had been drinking alcohol or a placebo. Incorrect evaluations give participants the opportunity to discuss alcohol-attributed expectancies. This intervention may take place over one or several sessions. The second type is an adaptation of the former scenario, but involves educational presentations. These vary in content, delivery (face-to-face, online) and intensity.

Although clear distinctions exist between these approaches, in practice, prevention or intervention programmes tend to use several components simultaneously in order to reduce binge drinking. Existing programmes often combine personalised normative feedback with BI or protective behavioural strategies, and address social norms by focusing on the individual’s motives or expectancies. The interventions mentioned above can therefore be seen as elements in a large toolbox of approaches to address the problem of binge drinking. However, this ‘pick-and-mix’ approach can make it difficult to separate and evaluate the specific effects that each element in a programme has; thus identifying the active and possible redundant parts of the intervention is almost impossible.

Individual interventions (II): specific settings

Emergency departments

Screenings for alcohol use, coupled with BI for those who have screened positive are tried-and-tested approaches deployed in primary care settings to prevent harmful drinking in the future (Kaner et al., 2007). Several studies found a preventive effect on binge drinking (Wurdak, Wolstein, & Kuntsche, 2016), others mixed evidence regarding different cultures (Cherpitel, Ye, Moskalewicz, & Swiatkiewicz, 2015), while others still
Based exclusively on US American trials, a systematic review and meta-analysis (Kohler & Hofmann, 2015) found that motivational interviewing was more effective in reducing binge frequencies among those under the age of 19 ($d = 0.21$, 95% CI [0.34, 0.07]) than any other intervention (e.g. standard care, written information, a contact list, phone follow-up and personalised normative feedback). Similar results were found in a meta-analysis of emergency care users of all ages who were positively screened for alcohol use (Schmidt et al., 2016). Among those who received BI, the reduction in binge drinking frequency was found to be greater than among individuals in the control condition ($d = 0.09$, 95% CI [0.03–0.15]). Although both meta-analyses found some evidence of the efficacy of motivational interviewing and BI in reducing binge drinking among those who presented to emergency departments, the effects found to date remain small-sized. The authors argue that this is largely due to the high heterogeneity of intervention characteristics (length, number of sessions, boosters, single vs. multiple components), comparison groups (treatment as usual, information, feedback), and outcomes (timeframe, alcohol measure) included in the single studies (Kohler & Hofmann, 2015; Schmidt et al., 2016). This assumption is in line with the results of two other reviews among young binge drinkers in emergency departments. The first review found no significant effects of BI on binge drinking reduction among patients younger than 20 compared to the control groups (Newton et al., 2013). The second review found little to no effect of BI among the 12–25 age group, and that the few preventive effects of BI found, varied considerably regarding the different alcohol outcomes considered (Diestelkamp et al., 2016). These results illustrate the need for high-quality studies in order to draw firmer conclusions on the usefulness of BI in emergency departments.

Interventions at parties and in Greek letter organisations

Settings and occasions with a specific binge drinking risk have triggered ‘event-specific prevention’ approaches, which are based on traditional alcohol interventions (BI, motivational interviewing etc., Neighbors et al., 2012). A recent review focused on the use of BI to address alcohol consumption during 21st birthday celebrations in the United States (21 is the legal drinking age in most states, Steinka-Fry, Tanner-Smith, & Grant, 2015). Eligible for inclusion were birthday-focused controlled studies with interventions delivered by postal mail or electronically, and thus involving no personal contact. The meta-analysis did not find any evidence that BI reduced the quantities of alcohol consumed during these celebrations ($g^1 = 0.05$, 95%CI [−0.03, 0.13]). However, in five of the nine eligible studies, it observed a protective effect on blood alcohol concentration (BAC) in the BI group compared to the control group (no treatment or general alcohol-related information; $g^1 = 0.20$, 95%CI [0.07, 0.33]).

Another setting in which binge drinking occurs more often among college students in the US (who already frequently binge drink) are fraternities, sororities and especially Greek letter organisations, i.e. student organisations that provide opportunities for social interaction, and are known for their secrecy, rituals and alcohol use (e.g. Scott-Sheldon, Carey, & Carey, 2008; Turrisi, Mallett, Mastroileo, & Larimer, 2006). A recent systematic review on the efficacy of alcohol interventions in Greek letter organisations (Scott-Sheldon, Carey, Kaiser, Knight, & Carey, 2016) included 15 US studies which reported the effects of 21 interventions in a meta-analysis. Most of the interventions
were delivered in groups and provided alcohol education, such as information on how to estimate BAC. About half of the studies provided alcohol reduction strategies, e.g. low-risk choices, skills’ training and alcohol use monitoring. The other half addressed high-risk occasions like parties. Frequency of binge drinking was only addressed in four of the 15 studies, and no significant differences were found between the intervention and control groups (i.e. waiting list, no treatment or alcohol-related information). Analyses of alcohol use on specific occasions/days came to the same result.

Overall, for specific settings among high-risk groups it seems that BI and motivational interviewing based on a positive screening for alcohol use are the most effective strategies, mainly when used in the context of special occasions, such as birthday parties or recent events, i.e. ending a night out in an emergency department. They are easy to implement within existing structures, brief in their delivery and less cost-intensive than approaches that focus on social norms or motives. Nevertheless, although BI (including motivational interviewing or personalised normative feedback) is widely used, studies to date have found that its impact on binge drinking is small and short-lived.

Programmes in the workplace

The workplace is another alcohol prevention setting (Ames & Bennett, 2011) and has the added potential of reaching a target audience beyond emergency departments and colleges who otherwise would be difficult to reach. In the US, about one third of full-time workers reported binge drinking within the past 30 days; 8.8% reported regular heavy drinking, though percentages varied considerably by occupation type (Substance Abuse and Mental Health Services Administration, 2009). Ames and Bennett (2011) provide an overview of different primary prevention programmes used in a workplace setting. Some took the form of individual approaches involving general health promotion, programmes that promote social support and a healthy workplace environment, and BI (including web-based personalised normative feedback). Other programmes focused on environmental approaches, including the availability of alcohol, social control, and norms that aim to reduce workplace-inherent risk factors for binge drinking. The studies found a positive effect when substance misuse prevention efforts like education, counselling and BI were included in general health promotion programmes (e.g. stress or weight management). However, the effect was observed only on the degree of willingness to reduce binge drinking, and not on the behaviour itself (Ames & Bennett, 2011). BI approaches revealed mixed results in the workplace setting, with better outcomes among female heavy drinkers and when delivered face-to-face or electronically. Ames and Bennett (2011) concluded that educational techniques (e.g. health promotion) combined with BI may have the greatest prevention potential in the workplace setting.

Individual interventions (III): approaches focusing on college students

As stated above, the behaviour of an individual is largely affected by the drinking behaviour of peers (Baer, Stacy, & Larimer, 1991; Neighbors, Lee, Lewis, Fossos, & Larimer, 2007; Perkins, 2002). Own perceptions of social norms and of alcohol use among peers are frequently overestimated (Borsari & Carey, 2003; Lewis & Neighbors, 2004). Social norm interventions aim to correct these normative beliefs and
misperceptions. A recent review and meta-analysis addressed the impact of social norm interventions on alcohol use and related consequences among undergraduates (Foxcroft, Moreira, Almeida Santimano, & Smith, 2015). Based on 16 studies (11,292 participants) and pooled across the different delivery modes (postal mail, Internet-based, face-to-face and marketing campaigns), the results revealed a small reduction of 2.7% in the number of binge drinkers the intervention group.

Personalised normative feedback was the focus of another meta-analytic review (Dotson, Dunn, & Bowers, 2015). Although binge drinking was not explicitly listed among the assessed outcomes, those receiving personalised normative feedback decreased their number of drinks per week compared to controls from baseline to follow-up (varied between 18 months and 10 years), based on gender-neutral ($d = 0.29, 95\% \text{ CI} [0.16, 0.42]$) and gender-specific feedback ($d = 0.28, 95\% \text{ CI} [0.12, 0.45]$).

As stated above, protective behavioural strategies, i.e. behaviours that mitigate the negative consequences of alcohol use, is another component of preventive approaches aimed at avoiding or reducing heavy alcohol use. A recent review among college students (Pearson, 2013) concluded that protective behavioural strategies is a central mediator for the success of other intervention components (BI, parental communication) on the reduction found for peak BAC. Nevertheless, results are mixed as some programmes failed to find an increase in protective behavioural strategies use in the intervention group and therefore could not find significant indirect effects of protective behavioural strategies on alcohol use. Consequently, it is not currently possible to draw a firmer conclusion about the usefulness of this concept for intervention efforts to reduce binge drinking even though alcohol-related protective behavioural strategies were consistently negatively associated with heavy or binge drinking.

Addressing alcohol expectancies with a view to preventing binge drinking was also the focus of a meta-analysis (Scott-Sheldon, Terry, Carey, Garey, & Carey, 2012) of 14 US American studies, two studies from the Netherlands and one from Sweden. Compared to the control condition (brief form of the intervention or assessment only), participants in the intervention reported lower positive alcohol expectancies ($d = 0.28, 95\% \text{ CI} [0.14, 0.43]$) and a reduction in binge drinking frequency ($d = 0.27, 95\% \text{ CI} [0.06, 0.47]$). Unfortunately, these protective effects were short-lived (i.e. less than 4 weeks follow-up).

**Individual interventions (IV): digital interventions**

In addition to the various intervention approaches for binge drinking presented above, developments in digital and mobile technology in recent years have brought completely new modes of intervention delivery. With increases in the use of the Internet, smartphone applications, and online social networks in Europe and worldwide (Pew Research, 2016), these media offer a tremendous potential to deliver low-cost interventions to a wide audience.

Several recent reviews have investigated the impact of online interventions (delivered via the Internet) on binge drinking reduction. Black, Mullan, and Sharpe (2016) conducted a meta-analysis to investigate the effectiveness of computer-delivered interventions for reducing alcohol use and included 47 studies using binge drinking outcomes. Overall, the included interventions had small effect sizes on binge drinking frequency ($d = 0.07$). More interestingly the authors conducted a meta-regression to
investigate whether specific aspects of the included studies (e.g. sample, location, length of follow-up) or intervention components (e.g. behaviour change technique, theory) had an impact on effect size. For binge drinking frequency, effects were stronger in the short term (≤1 month) than in the medium to long term (>1 month), when interventions provided personalised feedback on (behaviour change) performance, and when interventions were delivered to predominantly female samples.

In one review focusing on college students, only six studies actually investigated binge drinking as an outcome (Bhochhibhoya, Hayes, Branscum, & Taylor, 2015). Of these, five found a significant reduction in binge drinking frequency at follow-up periods ranging from six weeks to up to 24 months. Interventions resulting in significant effects included general personalised normative feedback (two studies), gender-specific feedback (one study), interactive online education consisting of tailored feedback, goal setting, stress management, and harm reduction (one study), and an online BI combining personalised normative feedback, goal setting, action planning, and enhancement of refusal self-efficacy (one study). The latter comprised an online screening test, together with personalised normative feedback and advice for drinking in accordance with low-risk drinking guidelines, a personal drinking profile, estimates of calorie intake from alcohol, drinking-related expenditure, and normative comparisons of drinking levels (Voogt, Kuntsche, Kleinjan, Poelen, & Engels, 2014; Voogt, Poelen, Kleinjan, Lemmers, & Engels, 2013). Further, the intervention instructed students to set drinking goals and provided tips on how to resist drinking in different situations with a view to enhancing their refusal self-efficacy. Compared to the no-intervention control group, the intervention resulted in no significant effects on past-week binge drinking prevalence at 6-month follow-up (Voogt et al., 2013). However, this was only the case when the analyses were based on single point assessments; i.e. when 26 weekly assessments were used in a latent growth curve analysis, participants in the intervention group had a sustained lower frequency of binge drinking over the entire 26-week period compared to the control group (Voogt et al., 2014).

Despite the promising results of intervention studies with college students, researchers have called into question the ability of online binge drinking interventions to achieve long-term effects among the wider alcohol-misusing population. A systematic review of online interventions, including seven studies on binge drinking reduction among populations who screened positive for alcohol misuse (Dedert et al., 2015), found no decrease in the proportion of binge drinkers or the frequency of binge drinking at 6-month follow-up compared to control conditions (information only, treatment as usual, or waiting list). The interventions investigated by the studies in this systematic review were usually one-time brief interventions consisting of personalised normative feedback, goal setting, psychoeducational, and coping skills training. The authors concluded that there was little evidence for longer-term, clinically significant effects, such as meeting drinking limits, and therefore recommended that future online interventions should provide more intensive treatment and in-person support, such as supplementary phone counselling.

Overall, the evidence for the effectiveness of online interventions to reduce binge drinking among college students has been predominantly positive, at least concerning the outcome of binge drinking frequency as opposed to binge drinking prevalence. Questions remain regarding the potential long-term impact and effect sizes of these interventions, especially when targeting alcohol-misusing and non-student populations.
While stand-alone online interventions can be delivered at low costs and are thus highly scalable, they may need additional in-person cognitive behavioural counselling components to boost their efficacy; these could be delivered via the phone, text messaging or online chats (Dedert et al., 2015). Further, given that many of the online interventions tested so far have differed in terms of content and approach, it is difficult to derive recommendations on what should and should not be implemented.

In addition to online interventions, which are usually delivered to a stationary computer at home, university, work place etc., mobile modes of delivery including text messages, smartphone apps and online social networking sites have become increasingly popular in recent years. The innovative and potentially very useful aspect of these technology platforms is their capability to deliver intervention content during people’s everyday lives, and to time it more closely around high-risk situations for binge drinking (e.g. weekend drinking: Suffoletto et al., 2015). They could also serve as a coping resource in these high-risk situations (e.g. Ecological Momentary Interventions: Beckjord & Shiffman, 2014). For example, one recent study tested a smartphone app that alerts recovering alcoholics when they are approaching a high-risk drinking location (e.g. a bar they used to drink in) and contains other intervention features and patient support services (Gustafson et al., 2014). Compared to treatment as usual, the app helped patients reduce the frequency of binge drinking days, although the utility of this technology for helping other populations who are not recovering from alcohol dependence remains to be tested.

Fowler, Holt, and Joshi (2016) conducted a systematic review of mobile technology-based interventions to reduce alcohol use among adults. Of all the studies in their review, five addressed binge drinking, of which four found that the intervention had a significant effect on binge drinking behaviour outcomes, either from pre- to post-test or compared to control groups (treatment as usual without mobile components): However, it should be noted that the effects were only found for up to four months post-intervention, and are thus relatively short-lived. The effective interventions were app- or text message-based, and provided psychoeducation, brief interventions, tailored feedback, and strategies to reduce drinking. The authors emphasised the promising, but still preliminary state of the research in this area due to the pilot nature of many of the studies they included in their review (Fowler et al., 2016).

While mobile technology-based interventions hold great promise, future studies with longer follow-up periods are clearly needed. Further, there is inconclusive evidence on the optimal dose of mobile interventions to obtain the best effects (Berman, Gajacki, Sinadinovic, & Andersson, 2016). Having said that, one previous review suggested that the length of interventions did not have an impact on effectiveness (O’Rourke, Humphris, & Baldacchino, 2016). Also, it should be noted that while there are now hundreds of commercial alcohol-related smartphone apps available on the iTunes and Google Play stores, less than 20% of apps promote alcohol reduction (Milward et al., 2016), and very few of these contain valid behavioural change techniques (Crane, Garnett, Brown, West, & Michie, 2015). Much research remains to be done in this area to both develop and test interventions for binge drinking that harness the potential of mobile technology.
Structural interventions: policy and environmental factors

In addition to the individual interventions reviewed above, the effects of alcohol policy measures on binge drinking are also of importance. Increasing alcohol taxes is one of the most effective policy instruments to reduce alcohol use at the population level (Babor et al., 2010). Two meta-analyses concluded that a higher price of alcohol reduces both the prevalence and frequency of binge drinking (Elder et al., 2010; Wagenaar, Salois, & Komro, 2009), although these effects may be smaller than on overall consumption (Wagenaar et al., 2009).

The alcohol policy environment (a scale of 29 policies including liquor licencing laws, accessibility restrictions, minimum legal drinking age laws, and others), over and above prices and taxes may also effect binge drinking prevalence (Naimi et al., 2014). When investigating the associations between the alcohol policy environment and the prevalence of binge drinking in US states, a recent publication found that the most promising policies to reduce binge drinking, in addition to increasing the price of alcoholic beverages, were those which targeted the general population (as opposed to policies focusing on underage drinkers), focused on alcohol consumption (e.g. policies focusing on the production, sale or use of alcohol rather on impaired driving), and reduced the availability of alcohol (Xuan et al., 2015). In sum, an effective political strategy to reduce binge drinking at the population level should contain both price increases and efforts to reduce alcohol availability.

Most colleges in the United States nowadays implement some alcohol policy measures alongside individual-centred strategies to reduce binge drinking among students (Lenk, Erickson, Nelson, Winters, & Toomey, 2012; Toomey et al., 2011). However, colleges vary in terms of the specifics of the policies they have elected to adopt. While bans on alcohol use at sport events are common, few colleges ban alcohol advertisements on campus, for example in newspapers and on radio stations. As well as the implementation of new or additional policies, the enforcement of existing policies may also have an impact on binge drinking. Stricter enforcement of college alcohol policies has been found to be associated with reductions in binge drinking prevalence over time (Harris, Sherritt, Van Hook, Wechsler, & Knight, 2010). Other promising alcohol control policies on college campuses include restricting alcohol sales (e.g. outlet density, hours of sales), increasing the price of alcohol, and restricting places for alcohol consumption (Toomey, Lenk, & Wagenaar, 2007). However, it should be mentioned that only a handful of the environmental strategies on college campuses have been tested as part of a comprehensive evaluation (Toomey et al., 2007).

Conclusions

Definitions and health impact

It seems unlikely that the scientific community will soon reach agreement on the definition of binge drinking. While it does not matter if the same phenomenon is labelled heavy episodic drinking, risky single occasion drinking or binge drinking, for comparative purposes though it is important that the amount consumed in a binge is standardised. In this respect, it is more important to define the number of standard drinks to yield an equivalent amount of pure ethanol instead of fixing the number of drinks to 5 + drinks, say, because this still would imply completely different amounts
due to variations across countries in terms of what constitutes a standard drink. For example, if the US defines binge drinking as five or more standard drinks, corresponding to 60–70 g of pure ethanol, then countries with 10 g as a standard drink should apply six or more drinks in their assessments (as is the case with the Alcohol Use Disorder Identification Test (AUDIT: Saunders, Aasland, Babor, de la Fuente, & Grant, 1993); in countries like the UK, where the standard unit is 8 g, this would have to rise to 8 + drinks. Encouragingly, attempts to make the amount comparable are currently underway (Standardizing Measurement of Alcohol-related Troubles [SMART], 2013).

However, perfect standardisation is highly unlikely given the differences across countries in vessel size, the volume of a standard serving, recall periods (7 days vs. 12 months) and the use or non-use of gender-specific measures. It is more important to distinguish between the assorted drinking patterns that underlie binge drinking behaviour. An analysis of individuals who have binged at least once in the past 12 months, for example, comprises very different drinkers (Gmel et al., 2011): from those who binge on very rare occasions (birthdays, New Year’s Eve) to those who are chronic heavy drinkers and so binge every day. The former pattern may (also) be associated with injuries, the latter mainly with liver cirrhosis.

It is important to further analyse the differential effects of single-occasion and frequent binge drinking, particularly in combination with usual volume drinking. Roerecke and Rehm (2010) showed that beneficial effects of moderate alcohol use on ischaemic heart disease did not persist among usually moderate drinkers if they also had infrequent binge drinking occasions. As regards adolescents, more studies are needed on the neurotoxic effects of binge drinking. Alternating episodes of intense intoxication with periods of abstinence may be deleterious for the brain (e.g. Maurage et al., 2012; Petit et al., 2014), hence the need for a more thorough investigation into the effects that a combination of repeated binge occasions (frequency) and ‘withdrawal’ periods (low volume phases) has on adolescent brain development.

Equally important is the study of the intensity of what constitutes a single binge. In some high-consuming countries, having five drinks from time to time may not be perceived as a risky drinking pattern, and drinking guidelines addressing such a quantity may not be taken seriously. In fact, a 5+ measure includes people who consume five drinks and those who drink 30 drinks on one occasion. Using a 5+ measure has been shown to be a good marker for consequences (Wechsler et al., 1994), yet this could be due to subsuming in this category the higher level drinkers who actually caused the effect. To convince policy-makers, adolescents, parents and practitioners that even low ‘binge’ levels come with risks, a clearer distinction must be made between drinking levels during a binge, and more dose-response analyses with consequences are needed.

**Correlates and determinants**

An important task for future research is to further disentangle the effects and investigate the interaction of psychosocial determinants on binge drinking at different levels (e.g. situation, individual and environment). Whereas binge drinking can occur in a stable, trait-like manner with only some fluctuations over time (Mushquash et al., 2014), situational factors may intervene and weaken the impact of individual factors such as personality. Hicks et al. (2015), for example, argue that despite the link between trait impulsivity and attentional bias among binge drinkers, it still remains to be
demonstrated whether impulsive binge drinkers actually have difficulty controlling their impulses after exposure to alcohol cues in a given situation. Other authors found that drinking motives, which are closely related to personality factors as described above, were only weakly related to the amounts consumed in a given situation, and argue that the effects of drinking motives and possibly also those of other individual-specific factors may be ‘overruled’ by situational characteristics (Grant et al., 2009; Kuntsche & Kuenig, 2012; Thrul & Kuntsche, 2016). However, even if there is no or little impact, individual characteristics or traits may still interact with situational factors. For example, pre-drinking (Kuntsche & Labhart, 2013a), the number of friends present at a drinking occasion (Thrul & Kuntsche, 2016) or the daily mood (Grant et al., 2009) have been found to moderate the impact of drinking motives on the volume of alcohol consumed on a given day.

To complicate matters further, the temporal sequence of psychosocial determinants or events appears to matter. Gottfredson and Hussong (2013) showed that whereas individual differences in affect variation over time and intra-individual fluctuations in affect within a day predicted alcohol consumption on a given day, the average level of negative affect experienced and self-reported drinking to cope did not – a finding that has been repeatedly replicated since (Kuntsche & Bruno, 2015; Simons, Wills, & Neal, 2014).

Fortunately, major advances have been made in terms of data collection techniques and analytical tools. The emergence of personal digital assistants and smartphones has led to more complex and sophisticated protocols to collect data in real life and in real time (Kuntsche & Labhart, 2013b, 2014). On the analytical side, software packages such as Stata, Mplus, and R have brought within reach the complex longitudinal analyses required to model multiple influences on multiple levels and time points. Unfortunately, most of the event-level studies available today report linear associations between a given exposure (e.g. number of friends present) and the number of drinks consumed in a given day, evening, or situation but not a threshold (e.g. 4+/5+), thus making it unclear whether binge drinking occurred or not (for an exception, see Kuntsche & Labhart, 2013a).

Interventions

Based on the reviewed literature on prevention of, and interventions for, binge drinking, we conclude that, despite the fact that many publications seem to address binge drinking, there are surprisingly few studies that actually report it as an outcome. In terms of the effectiveness of interventions to reduce binge drinking, there is evidence for small effects across different intervention approaches (e.g. brief interventions including personalised and normative feedback and drinking reduction strategies) as well as different populations (e.g. college students, young adults, patients in healthcare setting, and workers in their place of work). However, most of the evidence is derived from studies with young adults, and more specifically, college students. In recent years, many binge drinking interventions have been taken into the digital and mobile sphere. Delivery of interventions via the Internet, email and text messaging has shown some promise but the effects are generally weak. Future research needs to address the limitations of the current literature; few studies to date have tested interventions that use online social
networks and smartphone apps. Studies requiring longer term follow-up intervals may benefit from using more fine-grained assessment methods such as ecological momentary assessment, and rigorous randomised trials are needed that test interventions against active comparator conditions. Although several reviews and meta-analyses provide an overview of currently available evidence, the specific kind, content, or component of, or control group used in, the interventions subsumed under the same name (e.g. BI or personalised normative feedback) vary considerably from one study to the other, thus making comparisons difficult. Consequently, the observed effects must be very strong and robust to appear significant despite these differences in methodology and comparison. Moreover, ending a night out in emergency care may in itself be such a dreadful experience that it will lead the admitted person to reflect on their alcohol use regardless of whether they were the subject of an additional intervention or not. This may, as a consequence, limit the possibility of detecting intervention effects when comparing these individuals with a similar control group. Finally, future research should also seek to identify effective intervention components, for example through the use of factorial designs, since available studies frequently test a combination of components, which makes it impossible to differentiate between what works and what does not.

**General conclusion**

Being one of the most important concepts in alcohol research, interest in and published evidence on binge drinking has increased considerably over the past decades. Nevertheless, several challenges remain. For example, it is important to further analyse the differential effects of single-occasion and frequent binge drinking, to generate better knowledge about the neurotoxic effects of binge drinking particularly on the developing adolescent brain, and to more precisely determine what intensity constitutes a single binge. It is also important to further disentangle the effects and investigate interactions of psychosocial determinants on binge drinking at different levels (e.g. situation, individual and environment). Recent developments in data collection techniques (e.g. using personal cell phones) and statistical software have opened up the opportunity to conduct complex longitudinal analyses to test multiple influences on multiple levels and time points. Finally, there are still too few prevention or intervention studies that explicitly address binge drinking, particularly in populations other than young adults. This is regrettable since online social networks and smartphone apps offer exciting opportunities to prevent and reduce binge drinking.

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Note
1. Hedges’ $g$ is equivalent to Cohen’s $d$ but more appropriate for small sample sizes.

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