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Article:

Stevley, A.K. orcid.org/0000-0002-5637-5245, Holmes, J., McNamara, S. et al. (1 more author) (2020) Drinking contexts and their association with acute alcohol-related harm : a systematic review of event-level studies on adults' drinking occasions. *Drug and Alcohol Review*, 39 (4). pp. 309-320. ISSN 0959-5236

<https://doi.org/10.1111/dar.13042>

This is the peer reviewed version of the following article: Stevley, A.K., Holmes, J., McNamara, S. and Meier, P.S. (2020), Drinking contexts and their association with acute alcohol-related harm: A systematic review of event-level studies on adults' drinking occasions. *Drug Alcohol Rev.*, 39: 309-320, which has been published in final form at <https://doi.org/10.1111/dar.13042>. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions. This article may not be enhanced, enriched or otherwise transformed into a derivative work, without express permission from Wiley or by statutory rights under applicable legislation. Copyright notices must not be removed, obscured or modified. The article must be linked to Wiley's version of record on Wiley Online Library and any embedding, framing or otherwise making available the article or pages thereof by third parties from platforms, services and websites other than Wiley Online Library must be prohibited.

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Drinking contexts and their association with acute alcohol-related harm: A systematic review of event-level studies on adults' drinking occasions

Journal:	<i>Drug and Alcohol Review</i>
Manuscript ID	CDAR-2019-0286.R1
Manuscript Type:	Comprehensive Review
Date Submitted by the Author:	n/a
Complete List of Authors:	Stevely, Abigail; University of Sheffield School of Health and Related Research, Sheffield Alcohol Research Group Holmes, John; University of Sheffield, McNamara, Simon; University of Sheffield School of Health and Related Research Meier, Petra; Sheffield University, School of Health and related Research
Keywords (Please ensure that the Keywords and a short Running Head are also included in the manuscript file):	Alcohol Drinking, Systematic Review, Epidemiology, Adult

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Manuscripts

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3 **Drinking contexts and their association with acute alcohol-related harm: A systematic**
4 **review of event-level studies on adults' drinking occasions**
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51 Running title: Context and harm in adults' drinking occasions
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ABSTRACT

Issues

Event-level alcohol research can inform prevention efforts by determining whether drinking contexts - such as people or places - are associated with harmful outcomes. This review synthesises evidence on associations between characteristics of adults' drinking occasions and acute alcohol-related harm.

Approach

We systematically searched Ovid MEDLINE, Ovid PsycInfo, and the Web of Science Social Sciences Citation Index. Eligible papers used quantitative designs and event-level data collection methods. They linked one or more drinking contexts to acute alcohol-related harm. Following extraction of study characteristics, methods and findings, we assessed study quality and narratively synthesised the findings. PROSPERO ID:CRD42018119701.

Key Findings

Searches identified 95 eligible papers, 65 (68%) of which study young adults and 62 (65%) of which are set in the United States, which limits generalisability to other populations. These papers studied a range of harms from assault to drink driving. Study quality is good overall although measures often lack validation. We found substantial evidence for direct effects of drinking context on harms. All of the contextual characteristics types studied (e.g. people, place, timing, psychological states, drink type) were consistently associated with harms. Certain contexts were frequently studied and associated with harms, in particular, weekend drinking, drinking in licensed premises and concurrent illicit drug use.

Implications

The findings of our review indicate target drinking contexts for prevention efforts that are consistently associated with increased acute alcohol-related harm.

Conclusion

1
2
3 A large range of contextual characteristics of drinking occasions are directly associated with
4
5 acute alcohol-related harm, over and above levels of consumption.
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10 Key words: Alcohol Drinking; Systematic Review; Epidemiology; Adult
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For Peer Review Only

INTRODUCTION

Acute harms, such as hospitalisation due to injury, are an important part of the burden caused by alcohol consumption, accounting for an estimated 54% of alcohol-related deaths and 65% of years of life lost to alcohol in the United States [1,2]. Epidemiological research typically focuses on the relationship between consumption and alcohol-related harm [3–5]. However, alcohol consumption is not a uniform behaviour. It takes place as part of a range of activities such as relaxing at home in the evening or in a noisy pub watching football with friends [6], and there is emerging evidence that such contextual characteristics of drinking occasions are associated with harm independent of consumption [7,8]. Contextual characteristics also matter from sociological and political perspectives as politicians and other public health actors want to change not just drinking volume, but undesirable aspects of drinking culture [9–11]. Identifying potentially harmful contextual characteristics of drinking can usefully inform debate in these areas.

Contextual characteristics of drinking occasions affect acute alcohol-related harm by several mechanisms that may co-occur. Firstly, a contextual characteristic can be associated with increased consumption, which mediates the association between context and harm. For example, pre-drinking occasions are longer leading to greater consumption and subsequent harm [12]. Secondly, contextual characteristics can moderate the effect of consumption. For example, alcohol consumption is associated with unprotected sex with casual partners but not with steady partners [13]. Lastly, contextual characteristics can have direct effects on acute harm, independent of consumption levels. For example, playing drinking games has been found to increase alcohol-related harms beyond the influence of elevated intoxication, such as where drinking games are associated with situational norms conducive to risky behaviour [14–16]. If direct and moderation effects are common then research needs to measure harm

1
2
3 outcomes to fully understand the relationships between contextual characteristics and harm,
4
5 informing epidemiological modelling and policy making [17].
6
7

8 Our recent mapping review identified and described methodological features of event-level
9
10 studies estimating associations between contextual characteristics and alcohol consumption
11
12 and/or acute alcohol-related harm, including highlighting the predominant methodological
13
14 approaches [17]. We found a fast-growing body of literature that is diverse and fragmented
15
16 across disciplinary and methodological traditions. Early literature focused mainly on the
17
18 drinking environment in bars while more recent literature studies a heterogeneous range of
19
20 contextual characteristics, from the drinker's mood to the day of the week and time of day
21
22 [18]. Here, we build on our mapping review by providing a narrative synthesis and
23
24 interpretation of the results of the identified studies to inform practice, policy and future
25
26 research. Specifically, we aim to summarise the available evidence on direct and moderation
27
28 effects of contextual characteristics of adults' drinking occasions on acute harm outcomes.
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32

33 **METHODS**

34 **Search strategy**

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36
37 This review uses a subset of the studies identified by the systematic search of our recent
38
39 mapping review of event-level literature and was pre-registered using PROSPERO (ID:
40
41 CRD42018119701). The mapping review included papers with either consumption or acute
42
43 alcohol-related harm outcomes, whilst the present study synthesises only papers reporting
44
45 harm outcomes. The search strategy used for the mapping review is reported in detail
46
47 elsewhere [17]. Briefly, we used systematic searches of Ovid MEDLINE, Ovid PsycInfo and
48
49 the Web of Science Social Science Citation Index. The search strategy included terms for
50
51 three key concepts: alcohol consumption (e.g. alcohol* drink*), event-level research (e.g.
52
53 occasion-based) and contextual characteristics of drinking occasions (e.g. weekend) (Table
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2
3 S1). In our previous mapping review, we explained our approach to areas of the literature that
4 have already been reviewed. Readers interested in the relationship between illicit substance
5 use, alcohol use and domestic violence should refer to reviews by Choenni *et al.* [19,20] and
6 De Bruijn and De Graaf [19,20]. Readers interested in the combined use of alcohol with
7 energy drinks should refer to reviews by Verster *et al.* [21,22] and Peacock *et al.* [21,22]. The
8 remainder of the methods section pertains to the current systematic review. We adhere to
9 reporting guidance set out in the Preferred Reporting Items for Systematic Reviews and
10 Meta-Analyses (PRISMA) [23].
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22 **Eligibility criteria**

23 We include English language journal articles using quantitative, event-level methods (e.g.
24 ecological momentary assessment, experimental, and diary methods). Event-level methods
25 are methodologically diverse and well suited to studying contextual characteristics of
26 drinking occasions [17,24]. For instance, in experimental designs the researcher manipulates
27 the contextual characteristics of the drinking occasion, while ecological momentary
28 assessments collect reports from drinkers in real time (or close to it), and diary methods
29 collect retrospective data on specific drinking occasions.
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41 Studies use general adult population samples, or subsets of the general population (including
42 students), excluding research on special populations such as clinical or homeless samples.
43 Eligible studies measure one or more contextual characteristics of drinking occasions and
44 study their associations with one or more acute alcohol-related harms. Our understanding of
45 contextual characteristics is grounded in theories of practice and we use the term ‘context’ as
46 an accessible equivalent to ‘elements of practice’ [25]. Contextual characteristics include
47 materials (e.g. drink type or a pub), competencies (e.g. managing levels of intoxication) and
48 meanings (e.g. drinking to celebrate). This broad approach includes contexts that may have
49 direct impacts on harm independently of drinking alcohol (such as illicit drug use). These are
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3 included to comprehensively capture information on contextual characteristics within
4
5 drinking occasions.
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8 Eligible acute alcohol-related harms include all those listed in the 10th Revision of the
9
10 International Classification of Diseases and a review of alcohol-related burden of disease
11
12 [26,27]. Based on scoping searches, we also included unprotected sexual intercourse,
13
14 criminal activity and aggregate measures of acute harm (which combine a number of
15
16 different harms into one measure) (Table 1).
17
18

19
20 [Insert Table 1 here]
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22

23 **Screening and data extraction**

24
25 One reviewer conducted most screening and data extraction (AS). A second reviewer (SM)
26
27 independently reassessed full-text screening for 20 randomly selected papers. This check
28
29 demonstrated high consistency in the full-text screening. This study used a mixture of data
30
31 extracted for the mapping review (e.g. study design) and newly extracted data (e.g. results).
32
33

34
35 Data extracted included study identifying information, research design, the definition of a
36
37 drinking occasion used (e.g. single drinking location or the last 30 minutes), occasion
38
39 characteristics measured and the measures used for predictors and outcomes (e.g. question
40
41 asked and response scale used), statistical analysis methods, and findings (for each outcome
42
43 studied we extracted statistically significant associations).
44
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47

48 Quality assessment tools for the relevant type of observational study, as recommended by the
49
50 National Institute for Health and Care Excellence, were used to assess risk of bias [28]. We
51
52 used The Joanna Briggs Institute Checklist for Analytical Cross Sectional Studies, the
53
54 Critical Appraisal Skills Programme tool for case control studies, and the Cochrane Effective
55
56 Practice and Organisation of Care risk of bias criteria for interrupted time series studies.
57
58
59

60 **Analysis and reporting**

1
2
3 We use descriptive summary statistics to describe search results, study designs and
4
5 populations followed by discussion of overall study quality and narrative synthesis of
6
7 findings by acute harm outcome studied. The narrative synthesis focuses on direct
8
9 associations between contextual characteristics and acute alcohol-related harms, discussing
10
11 mediation and moderation via consumption where relevant. We have developed the following
12
13 contextual characteristic categories for ease of interpretation: people, place, timing,
14
15 psychological states, drink type and other. *People* refers to drinking companions including
16
17 measures such as the size and gender composition of the drinking group. *Place* incorporates
18
19 features of the location, most commonly drinking in licensed versus unlicensed premises (e.g.
20
21 in bars or at home). *Timing* characteristics include the day of the week and time of day.
22
23 *Psychological states* are situational and vary from day to day, as opposed to psychological
24
25 traits, which are enduring individual characteristics. The following examples can be studied
26
27 as either states or traits although only states are of interest for this review. Expectancies are
28
29 expectations about the outcomes of drinking [29], motives are the reasons people drink such
30
31 as ‘to cope with anxious mood’ and affect has a similar meaning to mood [8]. Finally, *drink*
32
33 *type* is the category of alcohol consumed, such as beer or spirits.
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40 Summary tables of the methods and findings of the included papers are available in Tables S2
41
42 and S3.
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44

45 46 **RESULTS**

47 48 49 **Description of the included studies**

50
51 Ninety-five papers are included (Figure 1) which are based on 77 studies – most studies are
52
53 reported in one (n=62; 65%) or two (n=12; 13%) papers [23].
54
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56
57 [Insert Figure 1 here]
58
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1
2
3 The most common study design reported in the included papers is single occasion recall
4 (n=42; 44%), in which respondents are asked to consider an occasion relevant to the harm of
5
6 interest and a comparator occasion (e.g. the most recent sexual experience in the case of
7
8 research on unprotected sex [13]) (Table 2). Other common designs are prospective daily
9
10 diary/ 24 hour recall (n=16; 17%), ecological momentary assessment (n=12; 13%) and
11
12 retrospective diary (n=13; 14%). There are no experimental studies.
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16
17 Studies collected information about drinking occasions but the definition of these occasions
18
19 varied across studies. Twenty-eight (30%) papers are based on contextual information
20
21 collected about drinking during an entire day. Seven (7%) papers consider drinking in the six
22
23 hours before an injury and seven (7%) measure drinking at one specific drinking location.
24
25 Many papers (n=44; 46%) do not explicitly define an occasion, allowing participants to make
26
27 this judgement themselves. For example, studies ask participants about contextual
28
29 characteristics of drinking prior to hospitalisation [30], during a worst date [31], or last night
30
31 [32], without specifying a length of time or number of locations that are of interest.
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35
36 Students (n=49; 52%) and other young people (n=16; 17%) are often studied - fewer papers
37
38 cover general adult populations (n=30; 32%). Most of the study populations are in the United
39
40 States (US) (n=62; 65%) with other studies set in Australia (n=9; 10%) and Canada (n=6;
41
42 6%). Few studies are set in non-Western countries (n=4; 4%).
43
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47 The acute harms studied are: aggregate measures of acute harm (measures based on multiple
48
49 types of harm) (n=30), unprotected sexual intercourse (n=24), accidental injuries and acute
50
51 hospitalisation (n=16), assault and aggression (n=15), drink driving (n=14), sexual violence
52
53 (n=9), acute alcohol use disorder symptoms (n=5) and criminal activity (n=3). Some eligible
54
55 harms are not studied by this literature (e.g. drinking in pregnancy).
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58 [Insert Table 2 here]
59
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Study quality

The quality of included papers is generally good. The main limiting factor is the use of self-report measures of occasion characteristics that lack validation. Some papers use well-validated self-report scales for more complex predictors, particularly psychological constructs such as drinking motives or mood [33,34]. Measures for some simple contextual characteristics, such as the day of the week, may not require validation. On the other hand, measures lacking validation are likely to be vulnerable to unknown sources of bias. Acute harms are also mainly assessed using simple self-report measures and less commonly using more robust measures, such as the Conflict Tactics Scale [35].

Around a third of included papers do not control for alcohol consumption in analyses (n=34; 36%). This is problematic, as studies which do not control for alcohol consumption cannot provide strong evidence for direct effects of contextual characteristics on acute harm.

However, they can evidence the importance of understanding which contextual characteristics are associated with harm.

Overview of narrative synthesis findings

Overall, we find contextual characteristics of all types studied (people, place, timing, psychological states, drink type and other) are directly associated with acute alcohol-related harms (Table 3), although drink type is only studied across a limited range of acute harm outcomes. Few studies considered moderation effects of drinking context. Most acute alcohol-related harms have been studied in relation to a variety of contextual characteristic types. However, unprotected sexual intercourse, sexual violence, acute alcohol use disorder symptoms and criminal activity have been less broadly studied.

[Insert Table 3 here]

Aggregate measures of acute harm

1
2
3 Aggregate measures of multiple acute harms are the most commonly studied outcome (n=30;
4 32%). These are usually based on a checklist of harms, sometimes adapted from validated
5 scales such as the Young Adult Alcohol Problems Screening Test [36]. Most of these papers
6 study student (n=25; 83%) or US (n=24; 80%) populations.
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12 People

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16 Students experience more harm, independent of increased consumption, when they drink in
17 larger groups [37,38] and mixed sex rather than same-sex pre-drinking settings [16]. The type
18 of company is generally not a significant predictor though having close friends who intend to
19 encourage the celebrant to drink alcohol at 21st birthday events (the legal drinking age in the
20 US) is linked to increased harm [36].
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28 Place

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31 Drinking in licensed premises is linked to increased harm, although students experience less
32 harm in restaurants [14,38–40]. Occasions involving greater numbers of locations are also
33 more likely to result in acute harm [15,41]. Pre-drinking is associated with increased risk in
34 students [16,42–44], although this may be wholly mediated by greater consumption [45].
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41 Timing

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44 Drinking later at night [15,41], during your 21st birthday week [46], at the weekend
45 [38,45,47], and during the weekend of an important college football game [48,49] is
46 associated with increased acute harm.
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51 Psychological states

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54 Higher subjective intoxication is associated with increased harm over and above the
55 contribution of consumption level [50,51]. Stronger drinking expectancies, both positive and
56 negative, are also associated with increased risk [38,52].
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Other

Further contextual characteristics associated with increased risk are playing drinking games, not serving food during the event, serving alcohol to the already intoxicated, music and dancing, receiving bar specials, lack of protective behavioural strategy use, and illicit drug use alongside drinking [14–16,37,39,40,53–56].

Unprotected sexual intercourse

Twenty-four papers use unprotected sex as an outcome, which is typically measured as self-reported condom use. Most of these papers study young adult (n=19; 79%) or US (n=18; 75%) populations. Thirteen papers collect data about specific recent events (e.g. recent intercourse).

People

Overall, studies of students, young women and adult men suggest unprotected sex is less likely when drinking with casual partners, particularly for young women who expect alcohol consumption to result in disinhibition [57]. Despite this, occasions with casual partners involve heavier alcohol consumption [58] and the level of alcohol consumption has a greater effect on the likelihood of unprotected sex (a moderation effect) [59–61]. This may be because contraceptive practices are less established with casual partners, leading to greater potential for variability and increased influence of alcohol consumption.

Timing

Emerging evidence among young women suggests that sex with known partners is more likely at the weekend, but there was no effect on the likelihood of condom use [57]. One paper studying students finds unprotected sex is more likely at the weekend, although this analysis did not control for increased sexual activity [51].

Psychological states

Studies of students and young adults find that high subjective intoxication increases risk of unprotected sex [51,62,63]. There is no evidence that drinking - or having sex to reduce negative mood when drinking - is associated with unprotected sex [64]. One paper reported that unprotected sex is more likely when drinking alcohol in a positive mood [65].

Other

Illicit drug use is studied by four papers with young adult samples, broadly finding no significant effect although marijuana use alongside drinking is associated with increased unprotected sex for young women with low sexual assertiveness [66].

A study of drinking on 21st birthdays found no evidence linking playing drinking games to unprotected sex [37]. Use of protective behavioural strategies, such as leaving the drinking event at a predetermined time, is associated with decreased unprotected sex [67].

Accidental injuries and acute hospitalisation

Most of this literature uses hospitalisation or emergency department attendance as harm outcomes (n=11; 69%). These papers use varied comparison groups such as patients with non-alcohol-related injuries or the same patient on a prior occasion.

People

Injuries are more likely to occur when drinking alone or in a group of more than two people [68].

Place

Alcohol consumption in licensed premises (such as pubs) is associated with injury [68,69] although most 'last drinks' prior to injury are in unlicensed premises (such as at home),

perhaps because drinking in unlicensed premises is more common [70]. Pre-drinking is also linked to increased hospitalisation among students [30].

Timing

Some evidence suggests most alcohol-related injuries happen early on Sunday mornings [70], after midnight [71], at the weekend [70,72,73] and during the summer [74]. National holidays are also associated with emergency department attendance [70–73].

Psychological states

Higher subjective intoxication is associated with an increased risk of injury [74].

Drink type

There are mixed findings for drink type - spirits [69], a combination of drink types and beer [75,76] have each been associated with higher risk of injury than not drinking by one paper.

Other

Illicit drug use does not predict increased injury risk in drinking occasions overall but is associated with injuries for men and those over thirty [68,74–77]. Prescription medication use during the drinking occasion is associated with a small decrease in risk of injury [68].

Assault and aggression

Fifteen papers study aggressive incidents such as being involved in a fight. They mostly focus on young adult populations (n=12; 80%).

People

Victim intoxication is associated with aggressive behaviour in young men [78] and young women are more likely to be aggressive towards other women [35]. Drinking in a larger group increases aggression victimisation [79] and perpetration through increased

1
2
3 consumption (mediation), while having a partner present increases the risk of aggression over
4 and above any effect on consumption [80,81]. Being in a social environment with others who
5 encourage aggression is also risky [78].
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11 Two papers on dating violence among female students in the US find alcohol consumption
12 particularly increases the risk of victimisation when drinking with long term partners (a
13 moderation effect) [82,83].
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18 Place

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21 Drinking in two or more locations, at a party (particularly for women), or in a university
22 residence/ fraternity versus 'other' location is associated with aggressive behaviour [80,81].
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26 Drinking in an aggression facilitating physical environment (based on a range of factors
27 including being loud, dirty and crowded) is also associated with increased aggression [78].
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31 Timing

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34 Overall, the findings on the effect of weekend drinking are inconsistent, with only one study
35 suggesting that aggression is more likely on a Friday or Saturday [51,81,84].
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39 Psychological states

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42 Among students, negative affect is associated with aggressive behaviour [84]. Angry affect
43 also moderates the effect of alcohol and marijuana use on perpetrating dating violence among
44 female students in the US. Alcohol consumption and marijuana use increase perpetration only
45 when participants are angry [82]. Higher subjective intoxication is protective for injury risk
46 but associated with increased aggression perpetration [78].
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55 Situation-level drinking to cope increases the likelihood of aggression while aesthetic
56 motives (e.g. to enjoy the taste) are associated with decreased risk [80].
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60 Other

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3 Other hazardous contexts include drinking to celebrate [79], with conflicting findings on
4 using illicit drugs among school leavers in Australia [37,67,85]. Drinking with a meal reduces
5 the likelihood of aggressive incidents [80,81]. High self-control demands (e.g. having to
6 regulate your thoughts or mood) is associated with increased risk of aggression and assault
7 [84].
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14 15 **Drink driving**

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17 Fourteen papers study drink driving, either directly (n=11; 79%) or through alcohol-related
18 road traffic accidents (n=3; 21%).
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22 23 Place

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25 Licensed premises are generally associated with drink driving and accidents; sales in
26 unlicensed premises are not associated with more accidents [86–88].
27
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30 31 Timing

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33 Some studies find that drink driving is more likely on Fridays, weekends, holidays and
34 evenings [86–89], but students may have a higher risk of driving drunk mid-week than at the
35 weekend [90]. Twenty-first birthday celebrations are associated with higher consumption but
36 not increased drink driving [91].
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43 44 Psychological states

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46 Also in students, higher objective intoxication and lower subjective intoxication is associated
47 with drink driving [90].
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51 52 Drink type

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54 Beer sales/consumption and the proportion of high strength beer sold in the last drinking
55 venue are associated with accidents while beer sales in unlicensed premises are protective
56 [88,92]. Beer is commonly drunk by binge drinkers and young people, and in public places,
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3 which may partially explain this relationship [93]. Some evidence links spirit sales in the last
4
5 drinking venue to crash risk [92].
6
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8 **Sexual violence**

9
10 Nine papers study sexual violence and primarily focus on victimisation rather than
11
12 perpetration. Sexual violence is typically defined as unwanted touching or physically forced
13
14 intercourse. Some studies include persistent unwanted sexual attention, verbally coerced
15
16 intercourse, and intercourse while incapacitated (i.e. intoxicated, passed out, or asleep). A
17
18 disparate set of predictors are used, making it difficult to draw conclusions.
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22 People

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24 There are contradictory findings on the effect of prior relationships between perpetrators and
25
26 victims on sexual violence when drinking [31,94].
27
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31 Larger, younger, female-dominated drinking groups in nightclubs are more likely to be
32
33 harassed [79].
34
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36 Place

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38 Drinking in isolated locations (such as at home) predicts male students perpetrating sexual
39
40 violence and alcohol consumption and pre-drinking are associated with victimisation
41
42 [31,79,83,94–96].
43
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45

46 Other

47
48 Playing drinking games on one's 21st birthday is associated with increased sexual violence
49
50 perpetration and victimisation [37]. Marijuana use [83] and drinking to celebrate [79] are also
51
52 associated with victimisation.
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54
55

56 **Acute alcohol use disorder symptoms**

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2
3 Five papers on acute alcohol use disorder (AUD) symptoms are included. Four of these use
4 ecological momentary assessment and study students in the US. AUDs are chronic
5
6 conditions, but this literature focuses on their acute symptoms [34].
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9

10 Timing

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12
13 AUD-related inpatient episodes are more likely on 19th birthdays (the legal drinking age in
14 Canada) and there are smaller increases on subsequent birthdays [97]. Occasions on Fridays
15
16 and Saturdays are consistently associated with increased AUD symptoms [32,98].
17
18
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20 Psychological states

21
22
23 Negative mood is associated with increased AUD both directly and indirectly through
24 increased consumption and coping motivations [32,34,98,99]. Emotional lability (variability
25
26 in affect during the day) is also associated with increased AUD [98]. On the other hand,
27
28 hostility (feeling angry, hostile or irritable) is associated with reduced acute dependence
29
30 symptoms despite increasing intoxication for men [99]. Daily enhancement motives (e.g.
31
32 because drinking is exciting) are directly associated with acute AUD symptoms [34]. The
33
34 relationships between mood, motives, and AUD symptoms at the event-level are complex -
35
36 these studies suggest both positive and negative mood may increase consumption and that
37
38 negative mood is related to increased AUD symptoms.
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45 **Criminal activity**

46
47 Three papers study criminal activity outcomes alongside other harms. These studies are
48
49 limited in scope, focusing on school leavers, 21st birthday drinking in the US and college
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51 students.
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55 Other

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2
3 These studies find that the odds of vandalism, theft and legal problems are substantially
4 higher when illicit drugs are used but are unaffected by use of protective behavioural
5 strategies or drinking game participation [37,67].
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10 **DISCUSSION**

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14 We find that a large number of contextual characteristics including people, place, timing,
15 psychological states and drink type are directly associated with acute alcohol-related harm.
16
17 Few studies tested for mediation or moderation effects. Compared to the other characteristic
18 types, drink type is studied across a limited range of acute harms. Areas of harm studied are
19 unprotected sexual intercourse, accidental injuries and acute hospitalisation, assault and
20 aggression, drink driving, sexual violence, acute alcohol use disorder symptoms and criminal
21 activity. Most of the identified literature uses young adult samples in the United States, which
22 makes it difficult to assess the generalisability of findings to wider populations. Compared to
23 other harms, fewer types of contextual characteristics are studied for unprotected sexual
24 intercourse, sexual violence, acute alcohol use disorder symptoms and criminal activity.
25
26 Within types of contextual characteristics, weekend drinking, drinking in licensed premises
27 and concurrent illicit drug use are commonly studied and consistently found to be associated
28 with harm. This reflects a literature which gives particular attention to some characteristics
29 but neglects others (such as dancing, positive mood and the age of drinking companions).
30
31 The findings of our review are constrained by limitations of the existing literature. Our recent
32 mapping review highlighted that papers often lack clearly stated reasons for the contextual
33 characteristics studied, and that few studies comprehensively capture occasion characteristics
34 [17]. As drinking occasions have not been clearly conceptualised, there may be important
35 contextual characteristics for understanding the situational drivers of alcohol-related harm
36 missing from the existing literature (e.g. toasting or downing drinks). The lack of
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3 comprehensive characteristics included in studies also limits the quality of study results, as
4
5 associations between contextual characteristics and acute harm may be related to unstudied
6
7 features of drinking occasions. A further limitation is that the diverse study designs used by
8
9 this literature have different advantages and disadvantages, and this may have impacted on
10
11 findings. For instance, studies using ecological momentary assessment or daily diary
12
13 approaches can account for inter- and intra-individual variation as they collect data about
14
15 multiple occasions [100] while studies asking participants to recall specific events are less
16
17 able to do so. However, study quality was generally good and most papers relying on
18
19 retrospective reports of specific events used case-control or case-crossover designs. Lastly,
20
21 few studies consider mediation or moderation effects and we therefore cannot come to an
22
23 informed conclusion on their likely importance.
24
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29 Despite these limitations, our review can inform harm prevention efforts. We have found
30
31 substantial evidence that contextual characteristics of drinking occasions are related to acute
32
33 harm and have identified potential intervention targets which are consistently associated with
34
35 harm. Furthermore, there is a growing evidence base for interventions altering drinking
36
37 environments in licensed premises [101,102]. Our review can inform future interventions
38
39 aimed at modifying drinking environments such as targeting illicit drug use or increasing the
40
41 availability of food. For example, an intervention could focus on working with licensed
42
43 premises to ensure that food is available at weekends or that premises are well-staffed.
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48 This is the first comprehensive review summarising evidence to date on the association
49
50 between contextual characteristics of adults' drinking occasions and any outcome. In this
51
52 case, we focus on acute alcohol-related harm outcomes. We have used a detailed search
53
54 strategy to identify this growing literature, which is spread across disciplinary and
55
56 methodological traditions, and considered a comprehensive set of harms. The main
57
58 limitations of this review include the use of a single reviewer to screen studies, although an
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1
2
3 independent re-assessment of twenty papers for inclusion demonstrated good reliability.

4
5 There was also no validation of data extraction. Since we did not include unpublished
6
7 literature, there is a risk of publication bias. However, this literature is heterogeneous and
8
9 widely dispersed [17] which suggests that searching for unpublished literature would be
10
11 challenging and there would still be a risk of bias. This is the most comprehensive review to
12
13 date and it draws on a diverse range of published records.
14
15

16
17 There is substantial evidence that contextual characteristics of drinking occasions are directly
18
19 associated with acute alcohol-related harms. However, this literature has not consistently
20
21 separated direct associations from potential effects mediated by consumption or moderation
22
23 effects of drinking context [5]. Furthermore, there is a lack of validated measures of
24
25 contextual characteristics and future research should focus on under-studied harms (such as
26
27 drink driving) and contextual characteristics (such as drink type and music/ dancing in the
28
29 venue), general population samples in addition to students, and additional geographical
30
31 locations. This would improve our understanding of acute alcohol-related harm, and add to
32
33 the evidence base informing the development of effective public health interventions. The
34
35 findings of our review indicate target drinking contexts for prevention efforts that are
36
37 consistently associated with increased alcohol-related acute harm, particularly drinking in
38
39 licensed premises, at the weekend and concurrently with illicit drug use.
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45 46 **ACKNOWLEDGEMENTS**

47
48 This paper presents independent research funded by NIHR School for Public Health Research
49
50 (NIHR SPHR) and the University of Sheffield. The views expressed are those of the author(s)
51
52 and not necessarily those of the NIHR or the Department of Health and Social Care. The first
53
54 author was also supported by the PGR Conference Fund at the School of Health and Related
55
56 Research, University of Sheffield.
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CONFLICT OF INTEREST

PSM and JH have received research funding from Systembolaget and Alko, the government-owned alcohol retail monopolies in Sweden and Finland.

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3 **TABLES**
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6 Table 1. Alcohol-related acute harms
7

Alcohol-related acute harm
Aggregate measures of acute alcohol-related harm ^a
Unprotected sexual intercourse
Accidental injuries and acute hospitalisation (fall injuries and other unintentional injuries)
Intentional self-harm
Victim of assault
Perpetrating assault
Intimate partner violence
Drink driving and transport injuries
Sexual violence
Mental and behavioural disorders (acute intoxication, dependence syndrome, withdrawal, withdrawal with delirium, psychotic episode)
Criminal activity
Mechanical forces
Drinking in pregnancy
Drowning
Intentional self-poisoning with alcohol
Other intentional injury
Alcohol poisoning, undetermined intent
Accidental exposure to noxious substances

32 ^a Aggregate measures of alcohol-related acute harm use several different harms to generate a
33 single measure. For instance, a checklist of harms could be used to calculate a score for the
34 total harm experienced.
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Table 2. Study characteristics

	Study characteristics ^a	Number of papers (percentage of the 95 included papers)
Design	Single occasion recall	42 (44)
	Prospective daily diary/ 24 hour recall	16 (17)
	Retrospective drinking diary	13 (14)
	Ecological momentary assessment	12 (13)
	Portal/ intercept survey	7 (7)
	Public services routine data (e.g. hospital records)	6 (6)
	Field studies	4 (4)
Definition of occasions	Participant defined	44 (46)
	One day	28 (30)
	One drinking location	7 (7)
	6 hours before an injury event	7 (7)
	Evening (after a certain time)	4 (4)
	Splitting the day into time segments	1 (1)
	Not clear	4 (4)
Population	Students	49 (52)
	General adult population	30 (32)
	Non-student young adults	16 (17)
	Experienced a specific harm ^b	13 (14)
	Female	12 (13)
	Male	5 (5)
	Risky drinkers	4 (4)
Country	United States	62 (65)
	Australia	9 (10)
	Canada	6 (6)
	Switzerland	5 (5)
	Brazil	2 (2)
	Ireland	2 (2)
	New Zealand	2 (2)
	England	1 (1)
	European	1 (1)
	Finland	1 (1)
	Latin American and Caribbean	1 (1)
	Norway	1 (1)
	Sub-Saharan African	1 (1)
	Sweden	1 (1)
Alcohol-related acute harm outcome	Aggregate measures of acute harm	30 (32)
	Unprotected sexual intercourse	24 (25)
	Accidental injuries and acute hospitalisation	16 (17)
	Assault and aggression	15 (16)
	Drink driving	14 (15)

Sexual violence	9 (10)
Acute alcohol use disorder symptoms	5 (5)
Criminal activity	3 (3)

^a Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. ^b For example, recruiting injured patients in accident and emergency departments.

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Table 3. Summary of evidence on associations between contextual characteristics and acute alcohol-related harms

	People	Place	Timing	Psychological states	Drink type	Other ^a
Aggregate measures of acute harm ^b	✓ 5/20 ^c	✓ 11/15	✓ 7/10	✓ 6/6	✗ 0/1	✓ 14/20
Unprotected sexual intercourse	✓ 8/10		✓ 1/1	✓ 4/6		✓ 3/6
Accidental injuries and acute hospitalisation	✓ 2/2	✓ 3/4	✓ 9/9	✓ 1/1	✓ 3/11	✓ 3/11
Assault and aggression	✓ 5/7	✓ 7/8	✓ 1/3	✓ 6/9		✓ 6/11
Drink driving		✓ 3/3	✓ 5/6	✓ 1/1	✓ 3/6	✗ 0/3
Sexual violence victimisation	✓ 5/6	✓ 1/3				✓ 3/3
Sexual violence perpetration	✓ 1/1	✓ 3/3				✓ 1/1
Acute alcohol use disorder symptoms			✓ 3/3	✓ 5/9		✗ 0/1
Criminal activity			✗ 0/1	✗ 0/1		✓ 1/3

^a For example playing drinking games, illicit drug use or drinking to celebrate. ^b Aggregate measures of acute harm draw together multiple types of acute harm to create a single measure. ✓ There is evidence of a significant association between a predictor in the contextual characteristic category and the acute alcohol-related harm outcome. ✗ There are paper/s studying association/s between a predictor in the contextual characteristics category and the acute alcohol-related harm but no significant findings. ^c Number of papers finding significant associations over the number of papers studying this association. These findings are shown for specific contextual characteristics in Table S3.

FIGURES

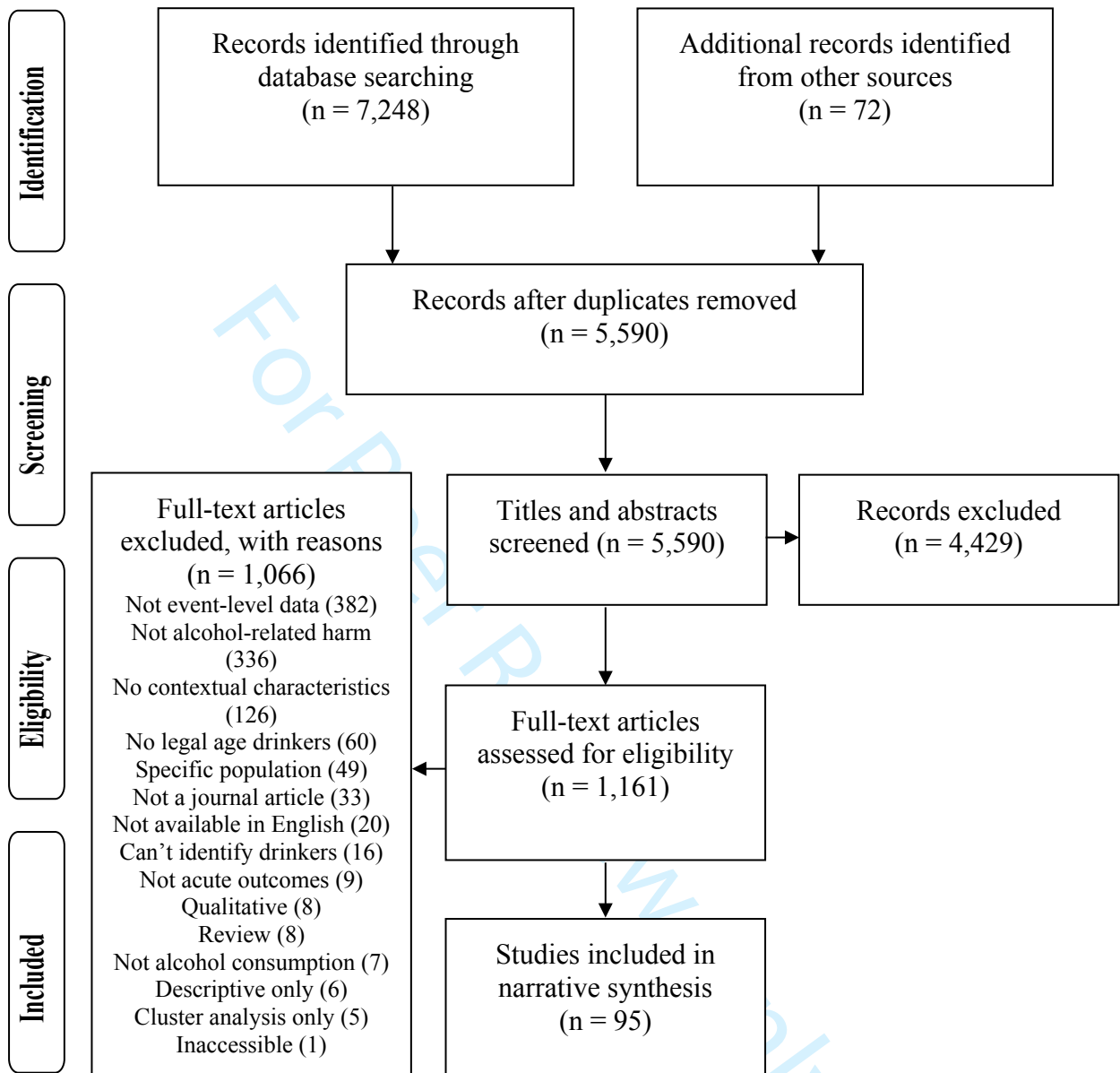


Figure 1. PRISMA diagram



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	2, 5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5-6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Table S1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7-8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7-8



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table S2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	19-21
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19-21
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

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URL: <http://mc.manuscriptcentral.com/dar> E-mail: dar@apsad.org.au

Table S1. Search strategy

Concept	Search terms			
Alcohol consumption (.mp.) (TS & TI)	bing* adj3 (drink* or consum* or intoxicat*)	alcohol* adj3 (drink* or consum* or intoxicat* or related)	heavy adj3 drink* alcoholic beverage* alcohol-related	
Alcohol consumption MEDLINE	exp Alcohol Drinking/			
Alcohol consumption PsycInfo	exp Alcohol drinking attitudes/	exp Alcohol drinking patterns/ exp binge drinking/	exp drinking behavior/ exp social drinking/	
Event-level research (.af.) (TS & TI)	ema ecological momentary assessment experience sampling diary diaries event level event level drink* adj2 event* event-specific event specific event-contingent event contingent referral event	occasion-based occasion based drink* practi?e* practi?e theor* theor* of practi?e* element* adj2 practi?e* recent* adj2 occasion recent* adj2 occasions recent* adj2 event last adj2 occasion	last adj2 occasions last adj2 event barroom bar-room bar room experimental setting experimental condition icat phone adj assessment text message*	portal survey rhdo ivr interactive voice response daily survey* handheld assessment tool* daily retrospective daily process realtime real time real-time daily account*
Contextual characteristics (.mp.) (TS & TI)	cocaine crack cocaine cannabis hashish marijuana cannabinoids (tetrahydrocannabinol) heroin ecstasy XTC amphetamines speed GHB MDMA venue* location* barroom bar-room bar* home	parent* beverage choice* beverage preference* beverage type* beverage-type* drink choice* drink type* drink-type wine* spirits beer* cider* alcopop* premixed pre-mixed pre mixed rtd* ready-to-drink* ready to drink*	Wednesday* Thursday* Friday* Saturday* Sunday* weekend* week-end* week end start-time start time duration night-time night time day-time day time daytime meal time* meal-time* mealtime* drink* adj3 mood	social support (subjective intoxication) subjective effect* (subjective experience*) (perceived intoxication) occasion adj3 type (occasion adj3 reason) party adj3 type party adj3 reason social purpose (purpose adj3 occasion) year* holiday* birthday*

Concept	Search terms			
	pub	(flavoured	alcohol adj3	semester*
	restaurant*	alcoholic	mood	gender
	street drink*	beverage*)	stress	composition
	nightclub	(flavored	affect	gender ratio
	club	alcoholic	anxiety	sex composition
	hotel	beverage*)	craving	sex ratio
	tavern*	drink* adj3	urge	male only
	bottle store*	(motive* or	desire	female only
	wine shop*	motivation* or	(pre-loading and	mixed sex
	shebeen*	meaning* or	alcohol)	mixed gender
	company	expect?nc* or	(pre-loading and	football
	companion*	reason*)	drinking)	rugby
	peer*	alcohol* adj3	(front-loading and	rowing
	friend*	(motive* or	alcohol)	match day*
	colleague*	motivation* or	(front-loading and	sport*
	family	meaning* or	drinking)	patron age
	partner	expect?nc* or	(drinking before	patron sex
	wife	reason*)	drinking)	patron ethnicity
	husband	day of the week	intention*	patron race
	spouse	Monday*	social	drinking game*
		Tuesday*	interaction*	
Contextual characteristics – situation (.mp.) (TS & TI)	dancing crowd* buy* adj3 round* facilities lighting	atmosphere music volume loud	discount* offer* promotion* marketing	advertising BOGOF drink* adj3 free alcohol* adj3 free
Exclusions for: MEDLINE	Therapeutics/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
PsycInfo	Treatment/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
SSCI (TS & TI)	Intervention effectiveness			

Table S2. Methods of included papers

First author, year	Design ³	Population	Country ¹	State	Outcomes ²	Occasion definition	Main statistical analyses
Abbey, 2001 [1]	Recall specific events	Male students	United States	Can't tell	Not occasion consumption Sexual violence	Participant defined	MANOVA
Aberg, 1993 [2]	Recall specific events	Adult male	Sweden		Not occasion consumption Drink driving	Participant defined	Lisrel, McNemar
Ahmed, 2014 [3]	Recall specific events	Students	United States	Mid-atlantic	Not occasion consumption Requiring medical attention	Participant defined	Logistic regression
Andreuccetti, 2014 [4]	Recall specific events	Alcohol-related A&E injured patients	Latin American, Caribbean		Not occasion consumption Requiring medical attention	Six hours before the injury event	Stuart Maxwell, McNemar's, Chi-square, student's t
Bourdeau, 2017 [5]	Portal survey	General/healthy adult	United States	California	Sexual violence Victim of assault	One drinking location	LCA, analysis of variance, chi-square
Braitman, 2017 [6]	Diary	Students	United States	Can't tell	Aggregate measure of acute harm	One day	Multi-level SEM
Brister, 2011 [7]	Recall specific events	Students	United States	Southwest	Aggregate measure	One day	Hierarchical linear regression
Brown, 2007 [8]	Recall specific events	Students	United States	Can't tell	Unprotected sex	Participant defined	Hierarchical logistic regression, chi-square
Brown, 2016 [9]	Recall specific events	Young women	United States	Southwest	Not occasion consumption Unprotected sex	Participant defined	Logistic and linear regression
Bryan, 2017 [10]	Diary	Adult female	United States	Washington	Not occasion consumption Unprotected sex	One day	SEM
Buettner CK, 2011 [11]	Diary	Students	United States	Midwest	Aggregate measure	Participant defined	Linear regression
Callaghan, 2014 [12]	Routine data	Young adults	Canada		Not occasion consumption Dependence syndrome	One day	ARIMA
Champion, 2009 [13]	Diary	Students	United States	Midwest & Midatlantic	Aggregate measure	One day	Logistic regression
Cherpitel, 1998 [14]	Daily diary/ 24hr recall	Experienced a skiing injury	United States	Northeast	Not occasion consumption Other unintentional injuries	One day	Logistic regression
Cherpitel, 1999 [15]	Recall specific events	A&E patients	Canada		Not occasion consumption Requiring medical attention	Six hours before the injury event	Logistic regression
Cherpitel, 2012 [16]	Recall specific events	A&E patients	Canada		Not occasion consumption Requiring medical attention	Six hours before the injury event	Conditional logistic regression
Clapp, 2000	Recall specific	Students	United States	California	Not occasion consumption	Participant defined	Logistic regression

[17]	events		States		Aggregate measure	defined	
Clapp, 2008 [18]	Recall specific events Field studies	Students	United States	Can't tell	Injuries Aggregate measure Aggression Rode with a drunk driver	Participant defined	Logistic regression and hierarchical models
Clapp, 2014 [19]	Field studies	Students	United States	California	Not occasion consumption Aggregate measure	Participant defined	Multi-level logistic regression
Collins, 2007 [20]	Recall specific events	Young women in an aggressive incident in a bar	United States	Can't tell	Not occasion consumption Perpetrating assault Victim of assault	One drinking location	Regression
Connor, 2014 [21]	Diary	Students	New Zealand		Not occasion consumption Aggregate measure	Participant defined	Conditional logistic regression
Cotti, 2014 [22]	Recall specific events	Risky drinkers	United States	Multiple states	Not occasion consumption Drink driving	Participant defined	Probit
Cousins, 2010 [23]	Recall specific events	Young adults	Ireland		Not occasion consumption Unprotected sex	Participant defined	Hierarchical logistic regression, SEM
Dvorak, 2014 [24]	EMA	Students	United States	Midwest	Dependence syndrome Aggregate measure	Evening (after a specified time)	Multigroup multilevel path model
Dvorak, 2016 [25]	EMA	Students	United States	Midwest	Dependence syndrome	Participant defined	Mixed effects negative binomial count model
Fairlie, 2018 [26]	Recall specific events	Young adults	United States	Multiple states	Not occasion consumption Unprotected sex	Participant defined	Logistic regression
Fillo, 2017 [27]	Recall specific events	Students	United States	Can't tell	Not occasion consumption Aggregate measure	One day	Hierarchical negative binomial regression
Ford, 2017 [28]	Recall specific events	Female students	United States	Can't tell	Not occasion consumption Sexual violence	Participant defined	Logistic regression
Foster, 2015 [29]	Diary Routine data	Young men	Switzerland		Transport injuries (inc RTA)	One day	Pearson's correlation coefficients
Fromme, 2010 [30]	Daily diary/ 24hr recall	Students	United States	Can't tell	Drink driving	Participant defined	Hierarchical Linear Modeling, GEE
Geisner, 2017 [31]	Recall specific events	Students	United States	West coast	Aggregate measure	One day	Paired t-tests, negative binomial regression
Gmel, 2005 [32]	EMA Routine data	General/healthy adult	Switzerland		Not occasion consumption Transport injuries (inc RTA)	Based on specified time segments	Pearson's correlation coefficients, multiple regression
Graham, 2014 [33]	Portal survey	Young women	Canada		Not occasion consumption Sexual violence	Participant defined	Multivariate logistic regression

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Greene, 2018 [34]	Daily diary/ 24hr recall	Students	United States	Northeast	Aggregate measure	One day	Multi-level mixed effects GLMs
Griffin, 2017 [35]	Routine data	General/healthy adult	Ireland		Not occasion consumption Intentional self harm	One day	Multivariate Poisson regression
Gruenewald, 1999 [36]	Recall specific events	Drivers who experienced crashes	Australia		Not occasion consumption Drink driving	Place of last drink	OLS regression
Gunn, 2018 [37]	Diary	Students	United States	South New England	Aggregate measure	One day	Generalized linear mixed models
Howells, 2014 [38]	Recall specific events	Female students	United States	Midwest	Not occasion consumption Unprotected sex	Participant defined	Two-level Bernoulli hierarchical analyses
Hummer, 2013 [39]	Recall specific events	Student risky drinkers	United States	West coast	Aggregate measure	Participant defined	Hierarchical Multiple Regression
Kenney, 2014 [40]	Recall specific events	Students	United States	West coast	Not occasion consumption Aggregate measure	Participant defined	Hierarchical multiple regression
Kerr, 2015 [41]	Daily diary/ 24hr recall	Students	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Multilevel logistic regression
Khurana, 2015 [42]	Recall specific events	Students	United States	Midwest	Aggregate measure	Participant defined	Multiple linear regression
Kiene, 2009 [43]	Daily diary/ 24hr recall	Students	United States	Connecticut	Not occasion consumption Unprotected sex	Participant defined	Multilevel logistic regression
Kiene, 2013 [44]	Recall specific events	General/healthy adult	sub-Saharan Africa		Not occasion consumption Unprotected sex	Participant defined	Binomial GLM with a logit link
Kilwein, 2018 [45]	Diary	Students	United States	Midwest	Not occasion consumption Unprotected sex Sexual violence	Participant defined	Generalized Estimating Equations: binary logistic regression with AR1
Kraft, 1991 [46]	Recall specific events	Young adults	Norway		Not occasion consumption Unprotected sex	Participant defined	Stepwise multiple logistic regression
Kuntsche, 2013 [47]	EMA	Students	Switzerland		Aggregate measure	Evening (after a specified time)	Multilevel regression
Kuntsche, 2015 [48]	EMA	Students	Switzerland		Aggregate measure	Evening (after a specified time)	GMM, multilevel logistic regression
LaBrie, 2008 [49]	Recall specific events	Students	United States	West coast	Aggregate measure	Participant defined	ANOVA
Labhart, 2013 [50]	EMA	Young adults	Switzerland		Aggregate measure	Evening (after a specified time)	Multilevel SEM
Lam, 2014 [51]	Recall specific events	Young adults	Australia		Unprotected sex Injuries Aggregate measure Perpetrating assault	Participant defined	Logistic regression

					Criminal activity		
Lang, 1995 [52]	Recall specific events	General/healthy adult	Australia		Aggregate measure	Participant defined	Logistic regression
Lau-Barraco, 2018 [53]	Daily diary/ 24hr recall	Young adults	United States	Can't tell	Aggregate measure	One day	Multilevel modeling
Leigh, 2008 [54]	Daily diary/ 24hr recall	Students	United States	Northwest	Not occasion consumption Unprotected sex	Participant defined	Random-effects regression
Leonard, 2003 [55]	Recall specific events	Young men in an aggressive incident in a bar	United States	New York	Perpetrating assault Victim of assault Aggression severity Injury to opponent	Participant defined	Logistic regression
Lewis, 2009 [56]	Diary	Students	United States	Midwest	Aggregate measure	One day	Negative binomial regression
Lewis, 2010 [57]	Recall specific events	Students	United States	Can't tell	Not occasion consumption Unprotected sex	Participant defined	Negative binomial and logistic regression
Linden-Carmichael, 2018 [58]	Daily diary/ 24hr recall	Students	United States	Northeast	Not occasion consumption Acute intoxication	One day	Generalized linear mixed models
Lubman, 2014 [59]	Portal survey	Young adults	Australia		Aggression Unprotected sex Injuries	Last 12 hours	T-test, chi-square, logistic regression
Madden, 2019 [60]	Recall specific events	Students	United States	Multiple states	Aggregate measure	Participant defined	SEM, factor analysis
Makela, 2005 [61]	Diary Routine data	General/healthy adult	Finland		Not occasion consumption Intoxication-related death	One day	Mortality rate ratios and confidence intervals
Mallett, 2017 [62]	Diary	Students	United States	Northeast	Not occasion consumption Aggregate measure	Participant defined	Multilevel modelling
McLean, 2009 [63]	Recall specific events	Alcohol-related A&E injured patients	New Zealand		Requiring medical attention	Six hours before the injury event	Chi-squared
Merrill, 2017 [64]	Diary	Students	United States	South New England	Not occasion consumption Aggregate measure	One day	Logistic TVEM
Mihic, 2009 [65]	Recall specific events	Students	Canada		Not occasion consumption Aggression	Participant defined	Hierarchical linear modeling
Miller, 2015 [66]	Portal survey	Alcohol-related A&E injured patients	Australia		Not occasion consumption Requiring medical attention	One drinking location	Pearson χ^2 tests
Naimi, 2007 [67]	Recall specific events	Risky drinkers	United States	Multiple states	Drink driving	Participant defined	Not clear
Neighbors,	Recall specific	Students	United States	Northwest	Aggregate measure	One day	Logistic regression

2014 [68]	events		States		Unprotected sex Sexual violence Drink driving Aggression Criminal activity		
Parks, 2000 [69]	Daily diary/ 24hr recall	Adult female	United States	New York	Not occasion consumption Victim of assault Sexual violence	One drinking location	Chi-square and ANOVA
Parks, 2011 [70]	Daily diary/ 24hr recall	Young women	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Multilevel modeling
Parks, 2012 [71]	Daily diary/ 24hr recall	Young women	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Hierarchical linear modeling
Patrick, 2016 [72]	EMA	Students	United States	Northwest	Aggregate measure	One day	Logistic and linear multilevel models
Quinn, 2011 [73]	Daily diary/ 24hr recall	Students	United States	Southwest	Not occasion consumption Unprotected sex Aggregate measure Aggression Criminal activity	Participant defined	Generalized Estimating Equations
Quinn, 2012 [74]	Daily diary/ 24hr recall	Students	United States	Southwest	Not occasion consumption Drink driving	Participant defined	Generalized Estimating Equations
Ragsdale, 2012 [75]	Field studies	Female students	United States	Florida	Rode with a drunk driver	Participant defined	T-tests, multiple regression
Santos, 2015 [76]	Portal survey	General/healthy adult	Brazil		Sexual violence Perpetrating assault Victim of assault	One day	Multiple logistic regression
Schroder, 2009 [77]	EMA	Students	United States	Texas	Not occasion consumption Unprotected sex	Participant defined	Hierarchical linear modeling
Searles, 1995 [78]	Daily diary/ 24hr recall	Adult male	United States	Vermont	Aggregate measure Drink driving	One day	Not clear
Shorey, 2014 [79]	Daily diary/ 24hr recall	Female students	United States	Southeast	Not occasion consumption Intimate partner violence	One day	Multilevel modeling
Shorey, 2016 [80]	Daily diary/ 24hr recall	Female students	United States	Southeast	Not occasion consumption Intimate partner violence Sexual violence	One day	Multilevel modeling
Simons, 2010 [81]	EMA	Students	United States	Can't tell	Dependence syndrome	Not clear	Negative binomial multilevel modeling
Simons, 2014	EMA	Students	United States	Midwest	Dependence syndrome	Not clear	Multilevel structural model

[82]			States					
Simons, 2016	EMA	Students	United States	Midwest	Not occasion consumption	Not clear	Multilevel logistic regression	
[83]			States		Perpetration of assault			
Simons, 2018	EMA	Young adults	United States	Can't tell	Not occasion consumption	Not clear	Multilevel multinomial regression	
[84]			States		Unprotected sex			
Stockwell, 1993	Recall specific events	General/healthy adult	Australia		Aggregate measure	Participant defined	Chi-square and logistic regression	
[85]								
Temple, 1992	Recall specific events	General/healthy adult	United States	California	Not occasion consumption	Participant defined	Logistic regression	
[86]			States		Unprotected sex			
Temple, 1993	Recall specific events	General/healthy adult	United States	Multiple states	Unprotected sex	Participant defined	Logistic regression	
[87]			States					
Todkill, 2016	Routine data	General/healthy adult	England		Not occasion consumption	One day	T-tests	
[88]					A&E attendance			
Treaeen, 2003	Recall specific events	General/healthy adult	European countries		Not occasion consumption	Participant defined	Logistic regression	
[89]					Unprotected sex			
Wagner, 2017	Portal survey	People who drove to the nightclub	Brazil		Drink driving	One drinking location	Multinomial logistic regression	
[90]								
Watt, 2004	Recall specific events	Alcohol-related A&E injured patients	Australia		Requiring medical attention	Six hours before the injury event	Conditional logistic regression	
[91]								
Watt, 2006	Portal survey	Alcohol-related A&E injured patients	Australia		Not occasion consumption	Six hours before the injury event	Multinomial logistic regression	
[92]					Injury severity			
Wells, 2008	Recall specific events	Students	Canada		Not occasion consumption	Participant defined	Multivariate multi-level models	
[93]					Aggression			
Williams, 2011	Recall specific events	Alcohol-related A&E injured patients	Australia		Not occasion consumption	Six hours before the injury event	Conditional logistic regression	
[94]	Diary				Requiring medical attention			
Yao, 2018	Field studies	Drivers who experienced crashes	United States	Virginia	Transport injuries (inc RTA)	Time when sampled	Logistic regression	
[95]					Drink driving			

¹ Not all papers report national-level studies. Sub-national information on the location of participants was not extracted. ² Aggregate measures of acute harm create a single measure of harm from several different harms. For example, a score for the number of harms experienced from a list might be used. ³ Portal surveys recruit participants as they enter or leave drinking venues, or intercept them on the street.

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Table S3. The numbers of papers finding significant associations between contextual characteristics and acute alcohol-related harms

Contextual characteristics	Aggregate measures of acute harm ^a	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
People									
Steady rather than casual partner		8/10 ^b				-1 ^c /1	1/1		
Drinking in a larger group	2/4		1/1	1/2		1/1			
Drinking alone	0/1		1/1						
Drinking with your partner	0/2			2/2					
Drinking with friends	-1/4								
Drinking with family/co-workers	0/4								
Male group	0/1								
Female group						1/1			
Mixed sex setting	1/2								
Young group						1/2			
Intoxicated people present	0/1			0/1					
No romantic relationships between group members						1/1			
People present who encourage aggression				1/1					

Contextual characteristics	Aggregate measures of acute harm ^a	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Friends with low pro-safety intentions and high pro-intoxication intentions at your 21 st birthday	1/1								
Female perpetration – male opponent				-1/1					
Place									
Licensed premises	4/6		2/3		3/3		-1/1		
Pre-drinking	3/3		1/1	0/1		1/2	1/1		
More pre-drinking locations	1/1								
More drinking locations	1/1			2/2					
At a party	1/2			2/2		0/1			
Off-campus residence/ party	-1, 1 ^d /2								
Isolated location							1/1		
Aggression facilitating physical environment				1/1					

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Contextual characteristics	Aggregate measures of acute harm ^a	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Drinking in a university residence or fraternity				2/2					
Timing									
Weekend	3/5	1/1	3/3	1/3	2/2			2/2	0/1
Weekend of an important football match	1/2								
Later in the day	2/2		2/2		2/2				
Holidays and other special occasions			3/3		1/1				
Winter season			-1/1						
Birthday when drinking becomes legal	1/1				0/1			1/1	
Psychological states									
Subjective intoxication	2/2	3/5	1/1	-1, 1 ^e /1	-1/1				0/1
Negative mood				1/1				2/3	
Positive mood		1/1						0/2	
Angry affect				2/3					
Hostility								-1/1	
Emotional lability								1/1	
Impulsivity				0/1				0/1	

Contextual characteristics	Aggregate measures of acute harm ^a	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Positive expectancies	2/2								
Negative expectancies	2/2								
Coping motivation				1/1					
Enhancement motivation				0/1				1/1	
Aesthetic motivation				-1/1					
Drink type									
Drinking beer			1/3		2/2				
Drinking spirits			1/3		1/2				
Drinking wine			0/3		0/2				
Drinking a combination of drink types			1/2						
Non-alcoholic drinks available	0/1								
Other									
Illicit drug use	3/3	2/4	-1, 1/7	2/4		1/1			1/1
Prescription drug use			-1/1						
Over the counter medication			0/1						
Drinking games	-1, 3/5	0/1		0/2	0/1	1/1	1/1		0/1

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Contextual characteristics	Aggregate measures of acute harm ^a	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Food available	-1/2				-2/2				
PBS	-1/1	-1/1	0/1					0/1	0/1
Music/dancing	2/2								
Genre of nightclub music					0/1				
Serving drunk people	2/3								
Drinking to celebrate/ big night out	0/1			1/1		1/1			
Themed party	0/1		0/1	0/1	0/1				
Receiving bar specials	1/1								
Bring your own booze	0/1								
Self-control demands on perpetrators				1/1					

^a Aggregate measures of acute harm draw together multiple types of acute harm to create a single measure. ^b The denominator indicates the number of papers studying this association. ^c Positive numbers indicate papers finding a positive association with harm and vice versa for negative numbers (protective factors). ^d Off-campus location is more risky for hosts while on-campus is more risky for attendees. ^e Protective for injury risk, associated with increased perpetration.